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1956 ANNUAL REPORT

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NORTHEASTERN FOREST EXPERIMENT STATION • • 1957

RALPH W. MARQUIS, DIRECTOR

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Programs & People

IF THERE EVER was such a thing as a "normal" year for the Northeastern Forest Experiment Station it occurred so long ago that no one here can remember it now. Certainly 1956 was a year of change--a changing appreciation of the needs for forest research, a changing emphasis in our program of research, changing organization, and changing personnel. Our hope is that all these changes add up to progress.

An increase in appropriated funds enabled us to make a modest start in several new lines of work. We entered the field of fire research and placed first emphasis on the analysis of problems to be given priority in further studies. We have added personnel to study the economics of forest production and to expand our studies in marketing forest products. And we established a new field headquarters office in cooperation with the University of Vermont at Burlington. Here we are started on basic studies of the commercial hardwoods. The program includes studies of soil-site-production relations, tree improvement, nursery and planting problems, and tree physiology. The field unit is a part of the White Pine-Hardwood Research Center at Laconia, N. H.

The Burlington program is a recognition, possibly belated, that the hardwoods of the Northeast represent an opportunity rather than a problem. The conditions leading to this conclusion are discussed more fully in the following pages. We are indebted to the Northeastern Forest Research Advisory Council for the active part it has played in analyzing changing conditions and for its continuing support for expanded hardwood research in the Northeast.

We have also come to realize that empirical research, valuable as it is, has limitations. It cannot give us all the answers. Accordingly our plans for the future envisage more research of a fundamental nature when the opportunity comes for an expansion of our activities.

During 1956 eight technical men left the Station. Kenneth Pomeroy resigned as Chief of the Division of Forest Management Research, to join the staff of the American Forestry Association. Ray Hansbrough left a similar position in Forest Disease Research when he transferred to the Washington Office. Tom McLintock left Bangor to become center leader at Lake City, Florida; and Sid Weitzman left the hills of West Virginia to become chief of the Division of Watershed Management Research at the Lake States Forest Experiment Station. Robert Lindahl also left the Mountain State Center to join the Regional Office in Upper Darby. Henry Gerhold took a fellowship with Pennsylvania State University. H. S. Potter and Ned Bethlahmy, both of whom had been on educational leave, found advancement elsewhere.

Fifteen new technical men, of whom three returned to school on educational leave, joined the staff of the Northeastern Station. Richard Lane, from the Carbondale Research Center, replaced Ken Pomeroy; and Marvin Fowler, from the Washington Office, took Ray Hansbrough's position in Forest Disease Research. Franklin Longwood, most recently from Puerto Rico, took over the direction of the Penobscot Center. Carl Stoltenberg came to us from Duke University to serve as head of the Resource Economics Section. John Staley, returning from military duty, joined the Forest Disease staff. Four men were added to the Forest Survey organization: Sam Brock and Orson Miller from the University of Michigan, Don Lester from the University of Maine, and William Zeedyk from the University of New Hampshire. George Hart (Michigan). Wilfred Mitchell (Maine), and John Phillips (Wisconsin) reported to the Mountain State Center in West Virginia. Herbert Tepper (Syracuse) and Edward Sucoff (Michigan) were added to the Laurel, Maryland, Center staff. William Leak (Syracuse) joined the Research Center at Laconia.

Henry Webster (economics) returned from educational leave at Michigan, and William Waters (insects) from Yale.

Wayne Banks moved from Economics to fire research. Robert Curtis, from Paul Smiths, and William Gabriel, from the Morris Arboretum, have moved to Burlington, Vermont.

Training of technical personnel continues to be an important activity in increasing the competence of our research men. During the past year Al Bickford gave a 3-week course in statistics to eight of our men; Charles Lockard trained a group at Laconia in photographic techniques and methods; a forest survey training meeting was held at Alfred

Maine; and all our watershed management research men, along with visitors from the Central States and Southeastern Stations, met at the Hubbard Brook Experimental Forest in New Hampshire. These special meetings were in addition to the regular on-the-job training programs in effect at all our field headquarters. A number of our men were able to visit other field headquarters in the Northeast and elsewhere in the United States. A conference at Split Rock Lodge brought together some forty of our junior staff for a 1-week meeting with division chiefs and staff specialists. During the present academic year six men, permanent members of the Station staff, are doing advanced work at universities: Sucoff at Maryland, Wilson and Lester at Yale, Staley at Cornell, Tepper at Syracuse, and Yelenosky at Penn State.

The following pages, telling the story of our program in different fields of forest research, are the contribution of Station personnel.

--RALPH W. MARQUIS, Director

Look to the Hardwoods!

THE NORTHEAST is hardwood country. To be sure, central and northern Maine and the higher elevations of the Green Mountains, White Mountains, and Adirondacks have their spruce-fir; cool, moist sites throughout the region typically support some hemlock; and white pine--the original foundation of the lumber industry in North America--is widely represented by scattered stands and by individual trees intermixed with other species. But in broad panorama, the forests of the Northeast take their predominant tone and character from the hardwoods. So it was in the days of the Pilgrims; and so it is today on the lands that remain in woods.

In the interim, land-clearing and settlement reached its peak. Then, particularly in New England, starting in the middle 1800's, came the era of land abandonment, followed by the growth of "old-field" pine, the cutting of these pine stands, and reversion of most of the temporary pine lands back to hardwoods.

Northern hardwoods, characterized by beech-birch-maple, plus varying proportions of hemlock and white pine, are or were predominant from northern Pennsylvania through most of New York and northern New England, exclusive of the spruce-fir areas. Oak types, in which chestnut formerly was an important component, predominate through central and southern New England, the Hudson and Mohawk valleys and south of Lake Ontario in New York, and from central Pennsylvania southward through Maryland and West Virginia. This, of course, is painting with a very broad brush. Various subtypes and transition types would have to be recognized in a more detailed description.

A BRIEF LOOK AT THE PAST

The virgin forests no doubt were magnificent and impressive to behold. However, not all of the trees by any means were quality specimens; in fact, a considerable proportion of them were overmature and defective. But there was, nevertheless, more than enough good and high-grade material to satisfy local needs and the demands of foreign trade during the period of settlement. During this period, timber products were largely a byproduct of land-clearing for agriculture; a lumber industry as such scarcely existed at that time.

The rise of the lumber industry in New England dates from about 1820, when agricultural development reached its maximum. The next few decades witnessed a rapid expansion of textile and other industries in the towns, drawing people from the farms. Another factor drawing people from the farms was increasing migration to the Midwest. As land-clearing for agriculture waned, lumbering as an industry grew. The lumbering of this era, up to about 1880, was largely a creaming or high-grading operation: only the larger, higher-quality trees of white pine, spruce, and a few preferred hardwood species were cut. Although there was no planned management for future production, the land was left in forest--somewhat deteriorated in quality but by no means devastated.

About 1880 marks the beginning of the period of extraordinarily heavy cutting in New England and the Northeast generally. Increasing demand for lumber, and increasing scarcity of high-quality sawtimber doubtless were factors in the changing practices; but the advent of the portable steam-powered sawmill seems to have been the turning point. With the moving of the mill to the woods, there grew up the custom of lump-sum sales of timber. The sawmiller, having paid for everything, and having his mill on the ground, took every stick that offered a remote chance of paying its way.

The result was not clear-cutting in the strict sense of the word, because all culls and the largely unmerchantable species like beech and red maple were left standing. But the woods were usually left in a sorry state, and fire not uncommonly followed in the slash. The widespread practice of such cutting ushered in the so-called hardwood problem that has been with us ever since.

PRESENT-DAY HARDWOOD FORESTS

In the twelve Northeastern States, according to the Timber Resource Review made by the U. S. Forest Service, 57 percent of the land is classified as commercial forest land, and 42 percent (of all land), or 53.5 million acres, is occupied by hardwood forest cover types. Distribution is of course not uniform; the hardwoods occupy a considerably larger proportion of all forest land in the Middle Atlantic States than in New England.

Northern Hardwoods In Better Condition Than The Oak Forests

The northern hardwood type, sugar maple-beech-yellow birch, occupies 21.3 million acres, almost equally divided between New England and the Middle Atlantic States. Oak-hickory occupies 21.8 million acres; with the oak-pine and oak-gum types added, the total for types dominated or strongly flavored by oaks is more than 25 million acres. Of this, close to 22 million acres are in the Middle Atlantic States. All hardwood acreage not included in the above figures is in aspen-birch or ash-elm-maple types; it totals about 7 million acres.

By and large, the oak forests are in worse condition than the northern hardwoods. Oak types tend to occupy drier sites, and consequently have suffered more damage from fire. Moreover, the oak types are found near the coast, in valleys such as the Mohawk and the Hudson, and often on less rugged terrain where industry and high populations have developed. Intensity of utilization therefore has been greater. Second- and even third-growth stands have been cut in many places. Charcoal wood, fuelwood, and mine-prop demands have resulted in extensive clear-cutting and the cutting of young stands. Removal of the chestnut from these stands by the blight was an additional blow from which many stands have not yet fully recovered. Also, in the New England area, oak forests have suffered repeated injury from defoliation by the gypsy moth.

As a result of their history of heavy but haphazard cutting, plus the cumulative effects of insect, disease, and fire damage, the oak forests--especially near centers of population--are now largely coppice growth, of poor form, and prevalently butt-rotted through fire scars and infection from the old stumps. Site quality very commonly has under-

gone deterioration from past fires. The scrub oak types found through the Poconos and westward in Pennsylvania are an extreme manifestation of site and stand deterioration, due primarily in this instance to repeated fires.

Fortunately, not all forests in the oak types are in such sad shape. Second-growth stands in the rougher sections of Pennsylvania, Maryland, and West Virginia have not generally been subjected to such intensive use; and though little silviculture has been applied to them, these stands are in many places in fairly good condition.

(The condition of the coastal oak-pine forests varies from fair to very poor. But despite the generally poor form, slow growth, and defects of the oaks and other hardwoods, many of these stands have a fairly good productive potential in the pines. The pines tend to be better adapted to the sites, and most of the type apparently can best be managed for pine. So, although these forests are mentioned here as part of the complex of types having a strong oak component, they are not, strictly speaking, a part of the hardwood-management problem, and would not be included in a program of hardwood-management research.)

The northern hardwood forests typically occupy moister sites than the oaks. They are distributed mostly in the mountainous sections, and in general they are more remote from centers of population. They have been cut over, but have not generally been subjected to the charcoal-wood, fuelwood, mine-prop type of utilization and to the repeated fires that have wrought havoc in many oak stands. The high-grading type of cutting that prevailed until about 80 years ago left many smaller trees and advance reproduction that soon filled in the holes where trees had been removed. Even the first "clear" cuttings after 1880 were not entirely devastating, unless followed by fire.

Because there usually was advance reproduction to develop after cutting, and secondly because stumps of the large old trees did not produce many sprouts, the second-growth northern hardwood stands typically were of fair quality. Overall quality was of course adversely affected by the culls and trees of low-value or of non-commercial species left by the loggers, but the second growth almost always included many seedling stems with a quality potential.

The real "hardwood problem" in the northern hardwood type develops when second growth is clear-cut at a compara-

tively immature age. The resultant third growth is of much lower quality because, with little advance reproduction established, and with stumps still young enough to sprout vigorously, the regeneration is largely of sprout origin.

Where fire has occurred, as has often happened in the slashings--even though the type is less fire-prone than the oak areas--the adverse effects of clear-cutting are compounded. Any white pine or other coniferous components are destroyed, the hardwood overstory is killed, to be followed by sprout and root-sucker growth. Weed species such as pin cherry, birch, and aspen seed into the bare spots. This sequence--clear cutting followed by fire--has given rise to most of the understocked low-quality sprout stands now found in the northern hardwood type.

Where there has been a succession of fires, the type tends to go over to aspen-birch. This is a weed type of little or no value when the birch element is mostly gray birch. Where paper birch is well represented, and if the site will support good growth of that species, the aspen-birch fire type may develop stands of considerable commercial value. There are 4.8 million acres of aspen-birch in the Northeast, but only a small part of this area supports stands of paper birch.

Poletimber Stands Predominate

Density of stocking and proportion of forest area in different stand-size classes are criteria of forest quality. However, the available figures are for all forest land, without breakdown by types. About 10 percent of the forest area in New England, and 15 percent in the Middle Atlantic States, is less than 40 percent stocked. In this respect the forests of the Northeast are in general better than those of other eastern regions.

As regards stand-size classes, 19 percent of the forest area in New England, and 24 percent in the Middle Atlantic Region, are in seedling-and-sapling stands or are nonstocked--again somewhat smaller percentages than in other eastern regions. Approximately one-third of the forest area in New England is classed as sawtimber, and about 36 percent in the Middle Atlantic States. The rest--48 percent and 40 percent respectively for the two regions--is poletimber.

The comparatively high proportion of poletimber stands is significant. It means (1) low yields of forest products in the immediate future, but (2) large areas of growing forest which can contribute to greatly increased yields a few decades hence.

The picture conveyed by the above figures is neither markedly bright nor markedly gloomy. True, there are understocked and depleted areas to give us concern, and there is a lot of poletimber too young for harvest cuts. But with poletimber or sawtimber growing stock on close to 80 percent of the forest land, the task of bringing these lands into a state of high productivity certainly is an attainable objective under reasonably intensive silviculture. The Northeast has, in this growing stock, an excellent raw-material potential for supporting forest industries. The job that faces research and management is to bring that state of high productivity to realization.

Scarcity Amid Abundance

With 53.5 million acres of hardwood forest in the Northeast, more than a third of which is classed as sawtimber stands, good hardwood timber is nevertheless a scarce commodity today. Yet for years people have talked of the "hardwood problem" as being largely one of getting rid of the hardwoods and replacing them with white pine, spruce, or other conifers. So we are in the anomalous position of deploring the scarcity of good high-utility hardwoods while surrounded by a plethora of hardwoods that are regarded as of little value or worthless--even though they are composed at least in part of the same species as those in demand.

This situation has developed from a century or more of cutting with little or no planned management for future production. Repeated high-grading of the better trees, leaving the culls and unmerchantable species to occupy space, has greatly reduced the proportions of such valuable intolerant species as black cherry, white ash, paper birch, and yellow-poplar. The tolerant species and those least in demand have increased proportionately, notably beech, which is both tolerant and in low demand. But the trees that are left, of whatever species, are predominantly low grade or culls. Where there has been fire or cutting of young second-growth trees, sprawling sprout clumps have taken over and,

in the absence of suitable cultural measures, promise little except low-grade material.

Hardwood Cut Is Much Less Than Growth

Although the cut of hardwoods in the Northeast is substantial--1.67 billion board feet in 1952--the cut is less than half the net annual growth. This compares with a softwood cut of 1.89 billion feet, which considerably exceeds growth but falls far short of local softwood requirements.

The very favorable ratio of hardwood cut to growth would seem to indicate that we are growing more hardwoods than we need. This undoubtedly is true for the low-quality trees that make up the bulk of the stands, which fact emphasizes again the scarcity amid abundance. For in the face of this favorable growth balance, such quality materials as tough ash, oak for bending and tight cooperage, high-grade sugar maple, and yellow birch for face veneer are scarce or almost nonexistent. With some other items, such as high-grade black cherry, scarcities are perhaps not quite so acute; yet the supply is short enough that phenomenal prices are paid for logs that meet certain specifications.

The hardwood market in general has higher quality demands than the softwood market. Except for the current upswing in use of hardwoods for pulp, there have been only limited outlets for the lower grade materials, and these at prices that offered little incentive to the producer. Moreover, extraction and conversion costs are higher for hardwoods than for softwoods. These are contributing reasons for the relatively low cut in relation to growth in our present-day low-grade hardwood stands.

A CHANGING ATTITUDE TOWARD THE HARDWOODS

General condemnation of the low-grade hardwood stands as worthless, with hopes of future returns built around conversion to conifers, has in recent years been giving way to a different point of view. True, on the sandy soils and other medium to poor hardwood sites, conversion to conifers

still appears to be the better course. But it is becoming increasingly recognized that most of the heavier soils are by nature better adapted to hardwood growth, and that on the better hardwood sites an inordinate amount of costly strong-arm work is required to establish conifers and keep them above the hardwood competition, even with the aid of modern silvicidal chemicals. Would it not be more logical and practical to work with rather than against Nature: devote our efforts to improving the quality of the hardwood growing stock and the production of good hardwood timber?

Increasing acceptance of the idea of devoting the better hardwood lands to sustained quality-hardwood production is crystallizing into a new attitude among both foresters and laymen that, we believe, presages a new era in northeastern forestry. Instead of deploring a hardwood problem, we are recognizing a hardwood opportunity--an opportunity to develop and get into practice silvicultural and management methods that will efficiently utilize the full natural capacity of these lands to produce forest products. The immediate tasks before us are to find out which sites or areas should be devoted to hardwoods, and how best to grow them on those areas.

Nothing in this sharpened interest in hardwoods involves any belittling or de-emphasis of white pine and other conifers. The demand for softwood timber continues to increase, and there should be no slackening in efforts to improve softwood management and expand softwood production. The new attitude only means greater recognition of the principle that each site or area is best adapted to certain kinds of trees or types of forest. Softwood sites would be given over to the culture of softwood forests, some sites might well be assigned to mixed softwood-hardwood types, and the sites best adapted to grow high-utility hardwoods would be devoted fully to their production.

The time is ripe, as it has never been before, for developing hardwood forestry.

One of the chief factors in transforming the problem of yesterday into the opportunity of today is the improved technology and expanding market for hardwood pulpwood. About a third of the wood going into pulp now is hardwood. With this market, it becomes profitable to remove much of the low-grade hardwood from stands in thinning and stand-improvement cuttings, and thereby build up a growing stock of good-quality trees. The job of putting run-down hardwood

forests under management thus becomes economically feasible from the time of the first conditioning cuts.

The favorable situation in the pulpwood field is further abetted by other technological advances--better knowledge on how to dry and use beech lumber, for example--and by the sustained high level of industrial and economic activity in the country. All this means markets for low-grade material, without which no substantial progress in improving hardwood stands is possible.

WHAT HAS BEEN DONE

To manage our hardwood forests, with their considerable number of species growing on a wide array of soil and site variations, requires both basic and practical how-to-do-it information. Although present knowledge of hardwood management is by no means a blank page, there are a great many blank lines. Observations and a limited amount of more formalized research over the past half-century have provided some pretty good general information on the site requirements, the relative tolerances, and the more important pests of the major species. We think we know some of the fundamentals of their management: which species can be grown in all-aged stands and cut by single-tree selection; which do better in even-aged stands or groups under some variant of clear cutting practices; which species should be favored on dry sites or moist sites, light soils or heavy soils, and so on. And we know that hardwoods are much more sensitive to adverse factors in field planting than are the conifers.

Questions, Questions

The blank lines on the management page show up when the forester comes face to face with specific cases and situations. For a specific combination of stand, site, accessibility, and markets, what species to favor? how favor certain ones and suppress others? how cut the stand? how obtain the desired reproduction? how much growing stock to carry? how minimize insect and disease losses? Or, considering special product requirements, on what sites and under what climates and management methods can wood of such properties as high density, toughness, or high bending strength be grown? In answering and acting upon all such questions

as these, the requisite information is incomplete, the guidelines not well established. The forest manager must, to a large extent, play by ear.

Site, for example, is a field in which very little basic research has been done in the Northeast. Good progress in soil classification and mapping of cultivated areas is being made by the Soil Conservation Service, but only a little of such work has been done in forested areas. Soil classification oriented to cropland agriculture is by itself of limited value in forest-site classification. There have been a few studies dealing with the forest-site-indicator significance of the low vegetation. The need in forestry is for site classification in which soil type, cover type, and the various physiographic factors are integrated to provide a basis for predicting growth and productivity by various tree species. Two studies of this sort have recently been done--one in Maine with reference to red spruce, and one in West Virginia with reference to oaks. These are helpful steps; much more work along somewhat the same lines should be done.

Regeneration--how to get natural reproduction of desired species or how to plant them--is a universal problem in forest management. Knowledge of site-species relationships is a prerequisite for wise choice of the species to be favored. As regards natural regeneration, foresters have a fairly good understanding of the seedbed requirements, tolerances, and competitive ability of our native hardwoods. Often a major problem in obtaining the desired reproduction is to suppress undesirable but more aggressive competitors. In part this may be accomplished by careful manipulation and timing of the harvest cuts. Failing in this, we may accomplish our purpose by weeding and release treatments. Although the basic principles are well known, much more research will be required to establish precisely how one can obtain natural regeneration of the different species in various situations.

As for planting hardwoods, it has been abundantly demonstrated that the conventional methods used for conifers generally fail. Various theories are extant as to why this is so, and as to what is required for hardwoods to succeed; but there are few successful hardwood plantings to cite as evidence. Hardwood planting is a field that is wide open for fruitful research.

Work in forest-tree improvement, or genetics, has been under way in the Northeast for about 30 years, with emphasis mainly on hybrid poplars. Since the war, a marked upsurge of interest in forest genetics has developed country-wide, centered largely upon conifers. In the Northeast, the Station has done a little preliminary work on hardwoods other than poplar--specifically on the birches, maples, and ashes. Except with the poplars, none of this work has progressed to the point where superior selections or hybrids are available for large-scale testing.

Forest-Wildlife Relationships

Wildlife in varying degrees is an important factor in forest management throughout the Northeast. Deer of course receive the most attention, both as part of the forest-land crop and as a pest that interferes with forest regeneration. In certain sections, notably northern Pennsylvania, an overpopulation of deer practically precludes the establishment of reproduction of black cherry, red and sugar maples, and most other native timber species except beech, thus making efficient forest management almost impossible. Rabbits, mice, and porcupines also are more or less destructive. Small planted trees of nearly all species are subject to damage by rabbits and mice, as well as by deer; rabbits and mice are particularly destructive of hardwood species. Many plantation failures have been caused mainly by wildlife depredations.

Both the Station and other agencies have maintained some fenced exclosures to demonstrate that deer and/or rabbits do in fact keep down the growth of tree seedlings, and to get a quantitative measure of the damage. Wildlife researchers have given us a pretty good understanding of the foot habits, preferred food-plant species, and nutritional requirements of the different kinds of forest wildlife, particularly for deer. But very little has been done in our region on methods for protecting trees or forests against wildlife, or on ways to minimize the damage.

NEGLECTED AREAS IN RESEARCH

With the great diversity of forest conditions found in our 12-state territory, it is but natural that some problems or aspects of problems should be neglected under the

limited research programs now under way. These may be considered briefly under the general headings of species and fields of study.

Which Species Need Study Most

In general, more silvical and silvicultural information is available for the commercially important conifers than for the hardwoods. Of the hardwoods, knowledge is somewhat more extensive for certain of the choicer species like white ash, yellow-poplar, white oak, and red oak. Less work has been done on the maples, birches, beech, hickory, basswood, and the lower-value oaks. Strange as it may be, black cherry has not been as much studied as some of the other hardwoods, despite the fact that choice logs command a higher price than those of any other northeastern species. This neglect is partly explained by the comparatively small commercial range of the species, and by the comparatively recent development of high demand in relation to supply.

The adequacy of information on the more important commercial species is of course relative; none has been wholly neglected by research workers, and none has been exhaustively studied. Much remains to be learned of the silvical characteristics of each species, and of how to translate silvical knowledge into effective silviculture and management practices. However, taking our northeastern hardwoods under today's market conditions and conditions in the woods, the following species may be named as having received comparatively little research attention, and as likely to yield good dividends from more intensive study.

- Black cherry. Major problem is how to perpetuate in it natural forest stands. Associated problems are protection against deer in seedling stages, control of seedling diseases, and how to establish the species by planting.

- Paper birch. The major problem, as with cherry, is how to perpetuate the species in natural stands. Associated problems are how to minimize post-logging decadence in partial cuttings and how to establish the species by planting. The dieback - bronze birch borer complex, though causing less concern now than a decade ago, also should be included among paper birch problems. This malady, which has marked similarities to post-logging decadence but may appear in un-

disturbed stands, and is believed to be caused by weather factors, still is somewhat of an enigma.

- Yellow-poplar. Again, major problems are perpetuation of the species, and how to plant it successfully. Inasmuch as good poplar sites usually are also very good for Japanese honeysuckle, control of this vine in some places is an important secondary problem in poplar management, and may be the determining factor in obtaining regeneration.

- Beech. In contrast to cherry, birch, and poplar, the major problem with beech is how to prevent it from becoming predominant at the expense of other more desirable species in the hardwood forest. Associated problems are how to produce higher quality material in the beech that is retained in the stands, and how to control or minimize the losses from the beech scale - nectria complex.

Two other species or groups may also be noted, since they are somewhat in the public eye. Sugar maple, which is of unique importance in parts of the Northeast as the source of maple-sugar products, is to receive attention at the Station's newly established unit at Burlington, Vermont. As a timber species, sugar maple poses less urgent problems than the species listed above. Secondly, the oaks as a group are of concern because of the oak-wilt disease and an unidentified dieback disease prevalent among red oaks in northwestern Pennsylvania and adjacent New York. Both diseases are receiving research attention. If either of these diseases should become a serious threat to our oaks, it would profoundly affect management problems and practices in the oak types.

Fields Of Study

Silviculture traditionally has drawn the major share of forestry research effort; and, as previously noted, a fairly good body of silvical and silvicultural knowledge has been built up. Much still remains to be learned, however, about the silviculture of all our commercial forest species, both softwood and hardwood.

A major need is for research to adapt the available generalized information to variations of climate, soil, site, forest cover and forest condition. The most effective application of known silviculture principles depends upon

such testing and adaptation.

Current waves of popular interest in other fields of study, worthwhile though they may be, should never be allowed to divert research efforts entirely or even largely away from silviculture. As the mainstay of forest science and practice, silviculture must remain a field of continuing investigation.

One neglected field of study, closely related to silviculture, is hardwood forest tree planting. Although a fair amount of empirical planting research has been done, the emphasis has been mainly on conifers. As noted earlier, hardwoods respond poorly to the usual methods of field planting, and have therefore been largely dropped from action programs in reforestation. Only a few sporadic attempts have been made to determine why the hardwoods fail, or what is required for them to succeed. Prior to World War II the Northeastern Station had started studies along these lines, but the project was dropped during the war and never reactivated. Now, with the upsurge of interest in hardwood forest management, the need to find out how to plant these species successfully takes on an added urgency.

Another neglected field, also closely related to silviculture, is investigation of soils and sites. The science of forest soils is a relatively new specialization in the broader field of soil science. Technicians are trained in forest soils in only a few schools, and still are scarce. Research calling for the skills of forest soil scientists is needed to develop ways and means to classify and identify the soil and site variants that are significant to tree growth and vigor, and to determine the relationships between those variants and different tree species. Better knowledge and understanding of site relationships will provide a much firmer footing for the practice of silviculture in managing our forests, and such understanding is essential to progress in solving the hardwood planting problem.

Forest tree genetics, though it has been on the scene for some 30 years, has until recently attracted little financial support, and except for the poplars, hardwood species have been almost wholly neglected. Little is known as yet of the extent of genetic variation in the important hardwoods, of the possibilities for selecting and propagating naturally superior strains, or for producing superior strains by hybridization. In fact, for sugar maple and probably some other species, problems in such facilitating

techniques as vegetative propagation must be solved before real progress can be made in the production of superior strains.

Other fields of study that have been neglected or only superficially worked include (1) how to produce wood of specific qualities such as high density or good bending properties; (2) optimum densities of stocking for various species or types on different classes of sites or in different geographic regions; (3) cost and return aspects of various silvicultural measures such as weeding, noncommercial thinning or release cutting, pruning, seedbed preparation, and the like for different species, forest types, sites, and regions; (4) control or evasion of wildlife damage; (5) silvicultural uses of herbicidal chemicals.

Finally, without pin-pointing particular fields of study, we can say that basic research as a philosophy and a method has been pretty much neglected in forestry. The approach in the past has been largely empirical, which has served us well, and will continue to characterize a substantial part of our research effort. But forestry has come of age to the point where we should dig deeper into the fundamental processes and reactions of trees and of the other life forms that affect tree growth. Forest research must begin to look more to the How and Why of things--into the physiological processes within the plant and into the ecological reactions of the plant with the physical, chemical, and biological factors of its environment. Such research provides understanding of causes and effects, and understanding in turn leads to more effective practices.

A RESEARCH PROGRAM FOR HARDWOOD FOREST MANAGEMENT

The Station has compartment and plot studies in hardwood silviculture and forest management now in progress at four of its research centers. For the most part this is empirical or applied research. These projects are yielding valuable results and will be continued. However, to put research in hardwoods on a scale more nearly consonant with the importance of the resource, a considerably expanded program is called for, as has been recommended by the Northeastern Forest Research Advisory Council. In such an expanded program the major emphasis should be placed on more

research of a basic character. The general direction and scope of such a program is indicated below.

1 Soil-site studies. This has been listed earlier as one of the neglected fields of study, and also in the review of research where two recent studies in the Station were noted. Information on site relationships is an essential foundation for effective work in planting, natural regeneration, and the silvicultural aspects of forest management. Site studies should be conducted at several of the Centers, and should eventually cover all the more important species in our region, both hardwood and softwood. Hardwood species that should be worked on include basswood, black cherry, yellow-poplar, white ash, sugar maple, oaks, white and yellow birches, and sweet gum. In the course of studies of these species or of the types in which they occur, we should also learn a good deal concerning site relationships of two less valuable but highly ubiquitous species--red maple and American beech.

2 Natural-regeneration studies. These should be concerned with ascertaining the physical and biotic factors that influence establishment of natural reproduction of the important species, and with finding ways to modify or control those factors to obtain desired reproduction.

3 Hardwood-planting studies. These should include (a) nursery studies, and (b) field planting. The latter should be concerned with essentially the same factors and objectives as in natural regeneration. The nursery studies could be mostly of an empirical nature, aimed at determining the proper levels of soil nutrients, moisture, seedling density, and other controllable variables for the production of high-quality hardwood planting stock. The Station is now committed to work along these lines, starting on sugar maple. In an expanded program, the studies should be extended to cover yellow-poplar, ash, cherry, and other species.

4 Basic physiological-ecological studies. These should also deal with the factors that influence seed germination and seedling growth, but with greater emphasis on the basic aspects and, as required, with use of more precise techniques than are implied in Nos. 2 and 3 above. We are particularly fortunate at our Beltsville Center in having access to the special facilities of the Agricultural Research Center. Investigations there can include laboratory and greenhouse studies as well as nursery and field work on the effects of such factors as light, temperature, moisture,

and nutritional levels upon germination and growth. At most of the other Centers, the investigations of necessity would be restricted to ecological field studies.

5 Wildlife relationships and control. These studies might be mostly empirical tests of control measures, or they might get into basic factors, depending upon the cooperative arrangements that may be possible, and the availability of properly trained personnel. If a wildlife technician could be permanently attached to the Station, some basic work on animal populations, nutrition, and the like would be possible.

6 Genetics. Additional work on hardwoods should be undertaken, probably at the Morris Arboretum. Attention should be devoted particularly to the birches, maples, oaks, yellow-poplar, and black cherry. We expect to continue field testing of the hybrid poplars.

7 Stand studies. These studies should be largely applied research aimed at determining optimum levels of stocking and stand structure for: (a) important forest types; and (b) different forest-management objectives. These should give us the number and size of trees for different ages, different sites, and different species mixtures that will yield the optimum continuous flow of a variety of forest products.

--W. E. McQUILKIN, Silviculturist

Forest Management

ESTABLISHMENT of a cooperative program with the Agricultural Experiment Station, University of Vermont, was one of the year's most significant and promising events in the Division of Forest Management Research.

The Program In Vermont

In this new program, basic research will have first priority, with genetics, tree physiology, and soils receiving primary attention. Initially we will concentrate upon artificial regeneration of superior hardwoods, with particular reference to sugar maple and Vermont conditions; and will undertake studies in genetics, soil-site characteristics, and outplanting practices. We are cooperating with the University on research designed to: (1) correlate soils and sites with growth of existing hardwoods and with the hardwood planting potential; (2) determine the factors influencing growth and yield of sugar maple, with immediate emphasis on superior sugar producers; and (3) explore the mechanism of sap flow as related to the cells and tissues of the maple stem, to changes in alcohol-extractable water in frozen and thawed wood, and to other factors.

Sugar-maple research under way at the Hopkins Memorial Experimental Forest and the Mount Hope Farm will contribute to the Vermont program. Several maples have been selected for source material in sugar-yield-improvement research. Repeat sap tests on these trees indicate that high sugar concentrations may be associated with low tree vigor. Several trees that gave over 8 percent yields at times during the tests have died or are in poor condition.

Seed was collected last fall from several above-average sugar-producing maples. These will be used to grow open-pollinated progeny from trees of known performance for

later tests at the Hopkins and at the University of Vermont. In addition, techniques for propagating sugar maple vegetatively are being developed. Of the methods used, air-layering has been the most successful. Observations indicate that complete gridling of branches yields more rooting than notching, and that 2-year-old wood yields more "catches" than 1-year-old wood.

Research In Tree Physiology Provides Promising Leads

Research on vegetative propagation also is being conducted at the Virginia Pine-Hardwood Research Center. An exploratory study with dormant Virginia pine cuttings was started to learn more about the effects of hormones and light upon rooting. This work is only partially completed, but for the first time Virginia pine cuttings have been rooted. Although the cuttings are now growing well, final results are not yet available. Other research under way here and in cooperation with the Agriculture Research Service includes:

- Factors affecting seed germination in Pinaceae genera. Virginia pine seed was used in the initial phases of this work. Best germination was obtained with light treatment followed by a 24-hour imbibition period at 5° Centigrade. A constant temperature of 25°C during the germination period proved best, with very poor results at 20 or 30°C. Light treatments in the red portion of the spectrum promoted germination but infra-red light completely inhibited it. These results were tested in the field with excellent response.

The same treatments helped in germinating loblolly pine but failed with white pine, indicating that species requirements are variable. Studies now in progress are expected to delineate optimum treatments for many other pine species. Our long-range objective is to devise preplanting methods that will increase germination, reduce costs, and perhaps eliminate or modify troublesome and erratic stratification procedures.

- Effects of light and nutrition on the growth of nursery stock. Nutritional supplements, in combination with light treatments, may result in more plantable stock per nursery bed, or in stock better able to withstand planting

shock, poor soils, and adverse moisture and temperature conditions. In our early tests, striking differences were obtained between nutritional levels and between light treatments. These studies are being expanded to include several conifers, one hardwood (white oak), light treatments at several intensities, and a variety of nutritional levels.

Genetics Research On Hardwoods & Softwoods

Forest-genetics research in both hardwoods and softwoods was continued at the Morris Arboretum and at some of the research centers. A part of last year's developments are briefed below.

For some time we have needed information about the opportunities of mass selection for genetical improvement of forest stands managed so that growing stock is replaced by natural regeneration. We need also to learn if continued harvesting of the best trees results in loss of some or all of the superior genotypes. This is particularly important in hardwood forests, which commonly have mixtures of both tolerant and intolerant species.

Last year we initiated an exploratory study to obtain some of this information. Naturally pollinated seed were collected from vigorous dominant black cherry trees and from smaller intermediate black cherry trees of the same age. These seeds were nursery-planted. The 1-year-old progeny of the dominant trees definitely were not superior in height to progeny of the intermediate trees--in fact they were generally inferior. The 1-year results of course are not conclusive. They are important, however, because the first year's growth of this intolerant species apparently is critical in its establishment and later development.

During 1955 we undertook a nationwide test of hybrid poplars developed by the Station. In this test, two cuttings each of four hybrids were shipped to approximately 3,500 cooperators. About 75 percent of the recipients gave us first-year reports, and the second-year results are being returned in encouraging numbers. We expect to summarize and report these results in 1957.

A weevil-resistant strain of white pine is urgently needed in the Northeast. We have attempted through field examination to determine how and where weevil resistance

might be achieved genetically. Western white pine plantations in New York and Pennsylvania were included in these examinations. In 11 locations where this species had been planted over 20 years, it had been consistently weevil-resistant and fast-growing in relation to eastern white pine. These characteristics seem to warrant planting it in mixtures with eastern white pine when weevil populations are high and blister rust incidence is low.

Two of 80 eastern white pine stands examined had consistently more variation in weeviling than would be expected from chance alone. This excess variability may be due to genetic factors. It hints, perhaps, that genetic selection could ultimately give us a more resistant tree. However, the rather low incidence of variable stands prevents us from being too optimistic.

We have noted that certain open-pollinated progeny of Austrian pine contained a high proportion of what is suspected to be Pinus nigra x densiflora hybrids. These apparent hybrids grew much faster in the nursery than seedlings of either parent species. In 1955 we attempted to mass-produce this hybrid and this year we harvested several hundred seeds from the cross. In addition, numerous other intraspecific hybridizations were made and seeds collected from still others during the 1956 season.

Regeneration Methods Are Being Developed

A part of the Division's total research effort is devoted to developing methods that will aid in forest regeneration. Some highlights of current results are:

- Prescribed burning is a useful tool for both natural and artificial regeneration of pine. Research in the use of prescribed burning as a cultural technique is being conducted by the Coastal Oak-Pine Research Center. In a mature stand of loblolly pine with hardwood understory, the composition had changed considerably in 4 years after shelterwood cutting and winter burning. The number of hardwoods above 0.5 inches in diameter has dropped 65 percent on the burned plots in contrast to an 8-percent increase on the unburned plots. The number of hardwoods smaller than 0.5 inches was not greatly affected by the burns but all advance pine reproduction was killed. However, both the burned and unburned plots had more pine reproduction 4 years after treatment.

Burning had no appreciable effect upon either survival or growth of the residual pine overstory.

Preliminary results from a direct-seeding test of pitch pine at this Center indicate that: (1) if seedbeds are at all unfavorable the area should first be prescribe-burned; (2) 1 pound of seed per acre on imperfectly drained sites and 2 pounds on well-drained sites may be adequate when sown in January or February; and (3) after seeding, the areas should be brush-hogged. This latter treatment clips back competing brush and lightly covers much of the seed.

● In 1948 we started research in reforestation methods on the Dilldown Experimental Forest in the Poconos of Pennsylvania. These studies are conducted in cooperation with the State. Our experience to date indicates that several species of conifers are adversely affected by competition from ericaceous ground cover but survive and grow reasonably well when such cover is removed. The best tool we have tested so far for site preparation is the combination of root rake and crawler tractor. It removes all vegetation in strips or patches, leaving bare mineral soil for a planting site. This year the State root-raked 150 to 200 acres at a cost of about $15 per acre--an acceptable rate. During the 1957 season they will plant about 175,000 conifers in the prepared areas.

In the middle of July about 60 acres on the Dilldown Forest were sprayed with several different herbicides to control brush and ground cover. The spray was applied with a mist blower, simulating aerial application of 3 to 5 gallons of solution per acre. Definite results are not yet available, but so far gray birch and sassafras were killed back to the ground, some scrub oak was killed back, and the ground cover remained green until frost.

Progress Made In Chemical Control Of Undesirable Trees

The use of chemicals in forest-improvement measures was studied at all research centers last year. The more significant results were:

● Frills in combination with chemicals effectively control northern hardwoods. With mixed species and sizes of northern hardwoods, top kills of around 85 percent may be

expected after frilling during the growing season and treating with 2,4,5-T or brush killer mixture in oil at 8 pounds acid per 100 gallons of solution. In this study the trees were frilled completely with an ax, giving careful attention to complete continuity across rough spots and cracks with ingrown bark. Costs were not a part of the study but records from a nearby action program in stand improvement provide a basis for reasonable cost estimates. In a program covering 2,000 acres in Maryland, "T" in oil solution was applied in frills. About 385 trees per acre, averaging 6 inches in diameter, were treated at a cost ranging from $13 to $15.

In another frill study, conducted by the Adirondack Research Center, ax cuts were spaced 3 to 4 inches apart and sodium arsenite solution was applied with a battery-filler syringe. Results indicate that application of a 40-percent arsenite solution in this manner is an effective technique for timber-stand-improvement work. This same treatment will cause bark-peeling if applied during the peeling season. Treatment costs were complied during application on 336 acres. The average cost was 1 man-hour per 8.5 square feet of basal area treated. One gallon of the arsenite solution treated about 110 square feet of basal area.

This technique has been widely accepted in the Adirondack area. It has already been used to improve both hardwood and conifer forests on about 5,000 acres of public and private land. Nearly 750,000 undesirable trees have been killed to reduce competition with selected crop trees. One company has scheduled annual improvement of 600-900 acres of their timber land, using this method; and others are expanding their use of it.

● Helicopter application of silvicides at the Massabesic Experimental Forest has been fairly successful in releasing white pine reproduction. Birches and oaks were completely controlled and some control of red maple and aspen was obtained in the 1955 tests, but fewer red maples were killed in the 1956 applications. Two concentrations of 2,4,5-T were applied on August 1, 1956: 3 pounds acid equivalent plus 1.75 gallons of fuel oil per acre and 2 pounds with 2 gallons of oil. Early results indicate adequate control can be obtained with the 2-pound application.

Complete Inventories Hard To Beat For Precise Volume Measurements On Small Areas

Another major activity of the Division is that of testing and demonstrating various management methods, systems, and levels on compartments, cutting-practice plots, and small woodlands. The high costs of repeated complete stand inventories provoked a study of inventory procedures for these experiments. Our objectives were to determine: (1) the magnitude of non-sampling errors such as mistakes, omissions, and duplications in complete inventories; and (2) if sampling could reduce the work load where repeated inventories were required.

As regards non-sampling errors, three successive complete inventories of identical areas about 25 acres in size revealed an average difference in recorded total basal area of approximately 0.5 percent. For 1/5-acre plots within these areas, the average difference was nearly 1.0 percent. Subtotals by species or size of tree showed considerably greater relative error. It was comforting to learn that these non-sampling errors could be kept to less than 1 percent when inventories are made with care. Before starting these tests, standard procedures for measuring abnormal trees were defined. This undoubtedly helped to keep the differences small.

To determine if sampling could be used efficiently, a large number of alternatives were compared. All sampling procedures tested relied on conventional plots 1/5 or 1/4 acre in size. There was no advantage to a complete tally of large trees with a sampling of small trees, to repeated use of a fixed sample, or to a series of independent samples. The relascope, which was not tested, might be a solution in a series of independent samples; and it should be given a trial.

Only one procedure tested looked promising in comparison with repeated complete inventories and the apparent efficiency here depends on a calculated correlation coefficient that may not be representative. This one promising procedure amounts to a complete inventory followed by an independent sample and then by sampling with partial replacement. For larger areas, of course, the value of sampling is well established; but complete inventories are hard to beat where precision is sought in measuring volume on small areas.

Long-Term Studies Produce Valuable Interim Results

Although most large-scale tests are necessarily long-term, they frequently yield valuable interim results. For example, the Mountain State Research Center began testing three levels of management for mine timbers in 1951. These tests were: (1) 8-inch diameter limit cut with a 30-year cutting cycle; (2) 12-inch with a 20-year cycle, and; (3) 16-inch with a 10-year cycle. At the end of 5 years the 12- and 16-inch limit compartments had approximately the same annual growth--230 board feet per acre. Since both compartments had about the same residual basal area (60 square feet per acre in trees 5.0 inches and larger) this was expected. Observations indicate that strict diameter-limit cuts are impractical on areas having a variety of sites; on good sites the 12-inch limit resulted in over-cutting, while on poor sites there were few, if any, trees large enough to cut.

Results from large cutting-practice plots established on the Finch Pruyn Experimental Forest in 1938 show: (1) repeated cuts reducing basal area to about 70 square feet per acre appear to be converting the stand to beech, while hard maple and yellow birch are not reproducing satisfactorily; (2) complete clear-cutting failed to give satisfactory reproduction, perhaps because of severe browsing by deer; and (3) a first cut reducing basal area to 50 square feet per acre resulted in excellent reproduction of hard maple, yellow birch, and white ash.

Another long-term research project yielded some tentative results this year. In 1937 a study of two pruning methods for sapling beech, sugar maple, and black cherry was started at the Allegheny Plateau Research Center. The methods tested for removing lower branches were: (1) flush pruning and (2) leaving 2- to 4-inch stubs. In 1956, 19 years after pruning, a few trees of each species were cut and dissected to observe the progress of healing and the possible defects associated with each pruning method. From the results, we can tentatively recommend flush pruning of lower branches in one or two stages to clear black cherry butt logs. For beech and maple the flush method can be used, but only at the risk of introducing stain and future decay. The stub-pruning method proved inferior to either flush or natural pruning in the three species.

Forest Fire Research Is Under Way

A forest fire-research program was initiated in the Division early last year. Preparation of a comprehensive analysis of fire-research needs in the northeast will be our first project. The analysis will be conducted state-by-state and will review the entire fire situation, including prevention, detection, communication, transportation, organization, equipment, fire-danger measurements, suppression techniques, and other similar aspects. Pennsylvania was selected for the first, or pilot, analysis. After the pattern is established, similar analyses will be made for the other northeastern states. Much of the data for Pennsylvania have been collected and preparation of the analysis is under way. In addition, a rate-of-spread study is being planned for the 1957 spring fire season. Several of the northeastern states and Region 7 are cooperating with us in this work.

--RICHARD D. LANE
Chief, Division of Forest Management Research

Watershed Management

RESEARCH IN watershed management during the past year involved analysis of data from long-term studies, completion of several short-term studies, preparation of problem analyses, and initiation of new research. Five papers were published and five were prepared for publication describing interrelationships of forest-cover conditions with streamflow, humus accumulations, incidence of concrete frost, snow accumulation, soil-moisture regimens, and other factors. Event of the year was a 3-day meeting of watershed researchers, devoted to shop-talk; the Hubbard Brook contingent played host.

Watershed Calibration

Several of our studies are designed to show how different treatments of the forest cover affect streamflow. The first essential step in these studies is to calibrate the untreated watershed. During the calibration period daily streamflow and climatic records are obtained. These must be complete enough to provide the basis for an accurate prediction of what streamflow would be on the treated watershed had it been left untreated. Only when we have such data as a basis for comparison can the later effects of treatment be detected. Therefore, deciding when we have records good enough to permit us to close the calibration period is an important event in a watershed-management project.

This past year marked completion of calibration on five of the Fernow watersheds in West Virginia and the Dilldown watershed in Pennsylvania. Accordingly, treatment was started at the Dilldown watershed, clearing oak brush (in strips) from 335 acres with a root-rake. The strips will be planted to conifers next spring. At the Fernow Experimental Forest treatment will start next year with a commercial clear-cutting of one of the five experimental watersheds.

In turn, the remaining three watersheds to be treated will be subjected to different degrees of cutting. One watershed will be left untreated for purposes of comparison.

New Watersheds

At the Fernow Experimental Forest, stream-gaging was begun on two additional forested watersheds, and cut-off walls were poured at two watersheds selected for study of the effects of converting mountain pasture to woodland. This brings the number of experimental watersheds at this forest to nine. Five additional precipitation-measuring stations were established.

Construction at the Hubbard Brook Experimental Forest continued with the clearing of three weir sites, construction of one weir, and building of 3/4 mile of jeep road. Two stream-gaging stations and one climatic station are in operation. For the next few years weir construction will continue at the rate of one or two weirs per year.

Problem Analyses

Two problem analyses were prepared. One, for the Kingston Center, stemmed in part from completion of calibration of the Dilldown watershed. The effect that replacing the scrub oak cover with conifers has on streamflow will be determined only after canopy closure, giving a period during which research can be started on other watershed problems. With this in mind, a watershed problem analysis was prepared which describes problems by land-use regions and outlines a 5-year research program. This will be published as a Station paper early next year. The program calls for watershed research in the oak region of Pennsylvania, watershed evaluation of steep idle lands and forest-occupied hardpan soils in southern New York, and watershed-rehabilitation studies in the Anthracite Region. As a first step, at year's end a search was under way for suitable experimental watersheds in the oak region for a watershed-research study in cooperation with the Pennsylvania State University School of Forestry and the Pennsylvania Department of Forests and Waters.

A detailed problem analysis and research program were also prepared as a basis for research at the Hubbard Brook

Experimental Forest. This report contains an evaluation of present knowledge of the effects of forest type, condition, and treatment on site factors that affect streamflow; a listing of deficiencies in knowledge; and a research program based on integrating small plots with watershed studies. This report will be published in a Station paper. One segment of it, dealing with the role of forest humus in watershed management, was published this past year (Station Paper 85.)

Streamflow &
Climatic Records

At the three centers where watershed research is conducted (Kingston, Mountain State, and White Pine-Hardwood) daily streamflow and climatic records were obtained on ten experimental watersheds. Two years of daily records at Kingston's Dilldown watershed were published in a third progress report. These three reports, printed by the Pennsylvania Department of Forests and Waters, contain 6 years of daily records and summaries of research results.

Soil-Moisture
& Soil Studies

Estimates of evapo-transpiration during the growing season were made in the New Jersey coastal plain from soil-moisture measurements under five types of cover: shortleaf pine poles, oak scrub, pine saplings, pine seedlings-oak sprouts, and a bare area. Results indicate that the pine pole, oak scrub, and sprout-seedling stands removed moisture to a depth of at least 12 feet; saplings dried the soil to a depth of 9 feet; and the bare area dried to a depth of 6 feet. For the 7-month period, total evapo-transpiration from the upper 5 feet of soil ranged from 17 inches for the bare plot to an average of 22 inches for the four forested conditions.

At the Fernow Experimental Forest, periodic soil-moisture measurements were begun on five experimental watersheds to determine soil-moisture regimens before treatment. Measurements will be continued after treatment to help account for significant treatment effects on streamflow. A feature of this study will be the testing of recently designed equipment for measuring soil moisture with radioactive materials.

A second study involving soils and begun this past year concerns the effect of water-spreading on tree growth, understory composition, and soil characteristics. This study was made at Seabrook, New Jersey, with cooperation of Seabrook Farms and the U.S. Geological Survey. Areas investigated have been subjected to 600 inches of water per year for the past 6 years. Field work has been completed and results will be published next year.

Also in preparation is a paper describing the methods used in the soils survey of the Hubbard Brook Experimental Forest. This survey, conducted in cooperation with the Soil Conservation Service, is, so far as we know, the first watershed-soil survey of its kind in the East.

A compilation of physical characteristics of 134 soils in seven northeastern states has been prepared for publication from data collected in 1954-55 by the Vicksburg Infiltration Project of the Southern Forest Experiment Station. Characteristics described include mechanical composition, bulk density, organic content, and moisture contents at saturation and field capacity.

Erosion Control

The problem of soil stabilization on logging roads received attention in two papers prepared this past year. One, which was published, described successful revegetation and soil stabilization at the Fernow Experimental Forest by seeding barn chaff at the rate of 20 bushels per mile of road together with applications of 400 pounds of 5-10-5 fertilizer and 1 ton of hydrated lime.

A similar study at the Bartlett Experimental Forest in New Hampshire has indicated that several grasses offer excellent protection against erosion on logging roads when seeded after application of 400 pounds of 10-10-10 fertilizer and 1 ton of dolomitic lime per mile of road. These grasses include red top, creeping red fescue, tall fescue, orchard grass, and barn chaff.

Construction of a jeep road with 36 open-top culverts at Hubbard Brook provided an opportunity to measure the distance that sediment from the road was carried from the mouth of the culvert downhill across the forest floor and, conversely, an estimate of the distance necessary to keep the

culvert discharge from reaching a stream. As can be expected, this distance varied with slope. Results yielded the following general rule-of-thumb: Starting with a strip 25 feet wide on level land, the width of the strip between the road and stream should increase 2 feet for each 1 percent increase in slope of the strip.

Snow
& Frost

Study of snow storage and melt in a northern hardwoods forest (at the Bartlett Experimental Forest) revealed that, in early spring, openings in a pole stand had 7 to 10 percent more snow water than the woods; and openings in a sawtimber stand had 4 percent more water--rather small differences. Snow melt was affected by tree shading. The study showed that snow accumulation can be increased and melting prolonged by cutting openings 30 to 40 feet wide in an east-west direction. Width of strips would vary with steepness of slope and height of trees.

The relation of land use and forest conditions to soil freezing and snow depths was analyzed from two winters' data collected bi-weekly at plots in six areas in the Northeast ranging from central Maine to northern Pennsylvania. Concrete frost intensity, as measured by its depth and frequency of occurrence, was 2 to 3 times greater in open lands than in brush lands and conifer sites, and 7 to 8 times greater in the open than in hardwood stands. As for snow depth, hardwood forest and brush had on an average 1.5 times deeper snow than was measured in the open; snow depths were 1.2 times deeper in conifer forests than on open land.

In cooperation with the staff of the Allegheny National Forest, a study of snow accumulation and melt was begun. Ten snow-survey courses have been located. Surveys will be made at times of critical snow accumulation. Correlation of measurements between courses will be studied to determine possibilities of using index stations to predict snow cover; and the relationship of snow melt to streamflow will be investigated.

--HOWARD W. LULL
Chief, Division of Watershed Management Research

Forest Insects

STATUS OF MAJOR PESTS

SPRUCE BUDWORM increased in both numbers and area of infestation in northern Maine. Noticeable defoliation extended over an area of more than 3,000,000 acres. The general infestation was light to medium, with some stands in the northeastern townships heavily defoliated. Next year will be a critical one in determining whether the infestation will increase to outbreak proportions.

THE WHITE PINE WEEVIL continued to cause severe damage, particularly in plantations. Plans were completed for a large-scale pilot-plant test of airplane spraying for weevil control in New York plantations next spring.

THE EUROPEAN PINE SHOOT MOTH has so severely infested red pine in western New York and Pennsylvania that the use of this tree for reforestation purposes has been curtailed. Christmas tree growers consider it a constant threat to their crop.

THE NANTUCKET PINE TIP MOTH has seriously affected loblolly pine plantings in Delaware and Maryland. Population levels were high in 1956.

PINE SAWFLIES caused serious damage to red pine in nearly all states in the region. The numbers and range of several species appear to be on the increase. About 1,200 acres of red pine plantations in northern New York were sprayed for control of Neodiprion nanulus. An infestation of N. pratti pratti on Virginia pine in the Patuxent drainage and surrounding territory in Maryland involved approximately 2,000 acres.

THE BALSAM WOOLLY APHID continued its depredations in Maine, New Hampshire, and Vermont.

THE PINE LEAF APHID was unusually abundant in northern New England and New York this year. Some mortality of

young white pines occurred in New York, Vermont, and Maine. Terminal galls on spruce, its alternate host, will be prevalent next year.

IPS BEETLES have been increasingly abundant for the past several years, particularly in pine plantations being thinned or pruned.

THE GYPSY MOTH was at a low ebb over most of New England. However, the recent spread of this pest into central New York and northern New Jersey and Pennsylvania presents a threat to susceptible forests southward and westward. Some 600,000 acres of the newly infested area were sprayed by the Federal Government. Over 300,000 acres were sprayed by state agencies.

THE MATSUCOCCUS SCALE infestation on red pine in Connecticut now covers an area of about 150 square miles. Spread is more pronounced to the north and east.

THE OLD HOUSE BORER is becoming increasingly destructive each year.

THE SADDLED PROMINENT was serious again in Rennselaer County, New York. The State sprayed 2,150 acres.

THE VARIABLE OAK LEAF CATERPILLAR and other lepidopterous species defoliated large areas of oak and mixed hardwoods in Maryland and Delaware.

RESEARCH PROGRAM

The principal insects involved in the research program were the spruce budworm, white pine weevil, Matsucoccus scale, gypsy moth, shoot and tip moths, balsam woolly aphid, pine sawflies, white pine cone insects, and the old house borer. The section that follows gives a brief resume of research on specific projects.

Spruce Budworm

Biological control.--Collections were made of small larvae in the buds, large larvae and pupae, and eggs, to determine the degree of parasitization of the budworm in eight

study plots in northern Maine. The percentage parasitization of larvae in the buds, and of pupae, was somewhat higher than in 1955 but was much lower for large larvae and eggs.

White Pine Weevil

Biology and ecology.--Studies showed that after exposure of weevil adults for 2 hours at a temperature of -10°F., 25 percent were alive; but after 16 hours only a few survived.

Tests were made with Iodine^{131}, Barium^{140}, and Phosphorus^{32} in an effort to find radioisotopes of relatively short half-life that might be used to tag weevils for dispersion studies. None of these raidoisotopes was satisfactory. After 30 days the tagged weevils had either died or were not detectable.

Studies of the effect of sterilization of weevil adults by gamma radiation indicated that when normal females are mated with irradiated males the eggs produced are sterile, but if the irradiated males are then replaced with normal males the eggs produced are fertile. Thus it would appear that the release of sterile males to control natural populations of the weevil would not be feasible.

Results of adult weevil emergence from oviposition tests on white pine leaders of different diameter size and bark thickness showed that leaders 1/4 inch in diameter and bark thickness of 0.130 millimeters or less produced practically no adults.

Biological control.--A rather striking case of the potential virulence of a disease of the adult weevil occurred when a high percentage of adults held in the laboratory in glass jars were killed by a parasitic fungus Aspergillus.

Preliminary tests with the Nematode DD 136 and its associated pathogen showed that white pine weevil larvae were readily infected in the laboratory, but attack was low under field conditions.

Chemical control.--Applications of granular Endrin made in October 1955 to control hibernating weevil adults resulted in over 99 percent weevil mortality by the spring

of 1956. Knapsack-sprayer applications of Lindane plus Arochlor made in January were effective in controlling white pine weevil adults upon emergence in the spring. Tests are now under way to determine if fall applications will be effective next spring.

Matsucoccus Scale
On Red Pine

Chemical control.--The objective of tests this year was to determine if repeated applications of chlorthion during one season would eliminate the scale on small groups of trees. Four applications reduced the scale population to an extremely low level but there were still a few survivors.

Gypsy
Moth

Biological control.--A 17-acre area of oak woodland, infested with gypsy moth caterpillars, was sprayed by airplane with 2 gallons of water suspension of the gypsy moth virus. The incidence of diseased caterpillars, however, was not substantially greater in the sprayed area than in a nearby check area.

Studies were initiated to develop techniques for rearing disease-free caterpillars in the laboratory as a basis for mass rearing of the insect. Millions of gypsy moth females are needed to provide sufficient sex-attractant extract for the trapping program being conducted by the Agricultural Research Service.

Preliminary tests indicated that sterilization of eggs with formaldehyde reduced virus infection. Other tests showed that feeding large caterpillars on lettuce (an unnatural food) failed to increase infection. When gypsy moth larvae were reared singly, in isolated containers, mortality from disease was low.

Chemical control.--Reports on tests conducted in Europe indicated that the gypsy moth could be completely controlled with a dosage of 1/20 pound of Endrin per acre. This dosage was applied by airplane in Connecticut and Vermont but the results were not satisfactory. In fact tests using double that dosage (1/10 pound per acre) failed to give satisfactory control.

Shoot &
Tip Moths

Biological control.--Collections of the Nantucket pine tip moth were made in Massachusetts and Maryland. Overwintering pupae are being held for parasite recovery.

Chemical control.--Eight insecticides (parathion, malathion, chlorthion, DDVP, OS 2046, Guthion, Thimet, and Endrin) were tested for control of the European pine shoot moth. None was effective. It is suspected that the timing of the tests may not have been correct.

Survey techniques.--The field data for a sampling study of the European pine shoot moth and Nantucket pine tip moth were obtained in New Jersey, Delaware, and Maryland. They will be used to develop a reliable means of sampling populations and injury and a meaningful and practical damage index.

Balsam
Woolly Aphid

Biological control.--Three colonies of Leucopis obscura adults, totalling about 2,000, were obtained in the spring of 1956 from collections made in Maine the previous fall. Two colonies of this predator were released in Vermont and one in New York. Recoveries of Leucopis obscura and another European predator, Laricobius ericksonii, were made at Somerset, Vermont, where they were released in 1954 and 1955 respectively.

Damage survey.--An analysis of data from small survey plots established from 1951 to 1953 on the White Mountain and Green Mountain National Forests showed that by 1956 balsam fir mortality on the plots ranged from 2 to 74 percent, averaging 30 percent. A survey of conditions on six 300- to 600-acre stands of softwood on the two National Forests indicated that current mortality of fir plus mortality likely to occur within the next 5 years from present aphid attack will result in a volume loss of about 32 percent.

Pine
Sawflies

Biological control.--About 200 acres of red pine, heavily infested with the sawfly Neodiprion sertifer, were

sprayed with a helicopter using 2 gallons of virus suspension per acre. At the end of the season only 21 living sawfly cocoons could be found after a careful search, indicating excellent control, certainly comparable to that obtained with insecticides.

White Pine
Cone Insects

Chemical control.--Applications of four different insecticides were made during the weeks of May 9 and June 4 with a mist-blower to control white pine cone insects on small groups of trees at the Massabesic Experimental Forest, Alfred, Maine. Six-percent emulsions of DDT, Dieldrin, malathion with Arochlor, and Lindane with Arochlor were used. The insects were active at the time of application, but fewer than 1 percent of the cones had been attacked. At the time of final examination, (August 20) over 95 percent of the unsprayed check cones were infested. All cones in the DDT and malathion treatments were infested. In the Dieldrin and Lindane treatments, 33 percent of the cones were not infested.

Old House
Borer

Chemical control.--Complete kill of larvae was obtained in large structural timbers with pressure or brush treatments of 5 percent DDT, 0.5 percent Lindane, or 2 percent Chlordane in kerosene or trichlorobenzene. The chemiclas were applied at the rate of $1\frac{1}{2}$ pints per cubic foot in the brush treatments and at 2 to 5 times this rate with a pressure gun. Control of an active infestation may require 6 months or longer, depending on the method of treatment used. Infestations in relatively sound wood are more difficult to control than those in severely damaged wood.

Willow Leaf
Beetle

Biological control.--At the request of the International Cooperation Administration, Djakarta, Indonesia, collections of willow leaf beetle pupae were made to recover the parasite, Schizonotus sieboldi. It was hoped that this parasite might attack an Indonesian species of beetle,

Plagiodera inclusa, which is a close relative of the willow leaf beetle, P. versicolora. A shipment of about 1,000 Schizonotus was made in August and another in October by ARS personnel. Some living females reached Indonesia, but reports to date do not indicate that the parasite is attacking the new host.

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A new publication, the NORTHEASTERN FOREST PEST REPORTER, was initiated this year to provide for timely interchange of information on the forest insect and disease situation in the region. Three issues (in July, August, and September) were distributed to a large number of agencies and interested persons. Approximately 375 requests for information on forest insects and forest products insects were answered.

--R. C. BROWN
Chief, Division of Forest Insect Research

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Forest Diseases

THE OVERALL forest-disease situation in the region has not changed significantly during the past year. However, an unexplained and large-scale dying of trees in the red oak group in recent years has caused increasing concern among foresters and pathologists.

Red Oak Dieback

Large numbers of immature red, black, and scarlet oaks have recently died in an area of approximately 8,000 square miles in northern Pennsylvania and southern New York. Mortality in one portion of a Pennsylvania State Forest has been estimated at 2,800 board feet per acre.

The Station began research on this disease early last summer. Information provided by cooperating agencies was assembled, and plots established in 1954 and 1955 by the Pennsylvania Department of Forests and Waters were examined. Symptomatology of affected trees was studied and culturing experiments were carried out. Preliminary survey flights were made to evaluate the possibility of and need for aerial surveys to delimit the affected areas and study the spread of the condition. Observations were made to determine site factors that might be related to the mortality. Available records of weather and stand history were assembled and are being studied.

Although dying oaks were found in most areas examined, their occurrence was less frequent than that reported in 1954 and 1955. Dying trees were those that had lost most of their crown branches in previous years. No instance of single branch dying was observed on trees exhibiting the growth reduction and chlorosis that typify early stages of the decline. Examination of the roots of such trees showed a low percentage of necrotic rootlets and no active patho-

genesis in larger roots. In contrast, trees now dying showed a high percentage of necrotic rootlets, with pathogenesis occurring in roots up to 1/2 inch in diameter.

Distinctive localized areas of cortical tissue exhibiting hydrosis and oozing were found on most, but not all, currently dying trees. These cankerlike areas appear to be associated with the galleries of wood-boring larvae.

The condition has been reported from scattered points in Pennsylvania and New York. It is most prevalent in the forested areas near Renova, Pa., and in the Allegheny Valley from Kinzua, Pa., to Salamanca, N. Y. A similar dying of red oaks has been reported in the southern portions of Pennsylvania. We have received reports of excessive red oak mortality in West Virginia, Virginia, and Wisconsin. Whether this is the same condition as that under study in Pennsylvania and New York is not known.

Oak
Wilt

Dieback and wilts are among the most damaging of tree diseases. Oak wilt is now known in 18 states, and is a potential threat to all commercial stands of oak in the East. It is established in Pennsylvania, West Virginia, and Maryland. These states are conducting oak-wilt surveys and operating control programs. This year infections were found only within the previously known limits of the disease, and in Pennsylvania fewer infection areas were found than in either of the two previous years.

Root
Rot

To test methods of controlling Fomes annosus root rot in established red pine plantations, an experiment was started in cooperation with the personnel of the Harvard Forest, Petersham, Mass. In 16 plots, with 75 trees per plot, 30 trees in each plot were cut. The stumps in half the plots were treated by brushing creosote on the cut surfaces in an attempt to prevent the development of root rot which might spread to adjacent trees. The remaining half were untreated. In 6 other similar plots, 30 trees were poisoned with sodium arsenite to determine the effectiveness of poisoning (as a thinning procedure) in relation to Fomes

annosus infection. Eight other plots of uncut untreated trees will serve for comparison.

A supplementary test on the control of Fomes annosus was begun in a planting of severely infected pines on the grounds of the Orchards Golf Course at South Hadley, Mass. Thinning had been done by a commercial operator in January 1956. In June, in two blocks of trees containing a total of 597 stumps, 325 were creosoted. The remaining stumps were tagged as checks. Since this commercial thinning was done in the winter, the results may vary from those of the test at the Harvard Forest.

Beech Dieback
& Canker

An inspection of dieback and canker of beech in the Moosehead Lake Region of Maine was made at the request of personnel of the Maine Forest Service. Leaves on small twigs scattered throughout the crown turn brown in late summer; the twigs die back; and cankers with roughened bark are formed on the trunk. In general, beech dieback follows the same pattern as birch dieback. Observations in the Belknap Recreation area, New Hampshire, and on Mount Ascutney, Vermont, revealed the same trouble. No exact diagnosis has been made.

Heart &
Sap Rots

As a supplement to the previously reported study of heart rot in old-growth red spruce on the Green Mountain National Forest, the organisms isolated from the rots are being identified. Three fungi that cause brown cubical rot and four that cause white butt rot have been identified. The importance of these fungi in connection with tree mortality is being evaluated.

At Paul Smiths Experimental Forest an exploratory study was made of deterioration in red maple trees poisoned with sodium arsenite. In general, deterioration in the trees that had been poisoned during 1951, 1953, and 1954 was negligible. A small amount of sap-rot was present beneath loosened, but still adhering, bark. Such rot was difficult to find on trees from which the bark had fallen. Fiber loss or yield reduction from the sap-rot is slight. These red

maples had been severely infected with heart-rotting fungi, principally Fomes igniarius. Swollen knots along the trunk and swollen areas around old dead branch stubs indicated the presence of cull-producing heart rots.

Blight-Resistant Chestnut Trees

The search for blight resistance in American chestnut trees continues. Forty-seven old American chestnut trees are under test to determine if their survival is due to genetic characteristics or merely to chance. Scionwood from these trees was distributed to some 60 cooperators in 27 states. Reports received indicate that, of a total of 821 attempted grafts, about one-fourth have made successful union with root stock. It is too early to evaluate the results of this work.

Plots established to test disease resistance and growth characteristics of various strains of Asiatic chestnut trees and hybrids were re-examined this year. The Chinese chestnut P.I. 58602 continues to be superior to the others tested.

Preventing Decay Of Wood In Use

The installation of soil covers under basementless houses continues to control decay in subfloor timbers. Smooth asphalt-covered papers, waterproofed laminated papers, and thin metal foils spread over the soil reduce moisture condensation on the timbers. The soil covers have proved effective even without ventilation of crawl spaces.

Data have been taken on a test of chemicals applied to the soil for the control of four dry-rot fungi. The four fungi were established in 192 test plots prior to the application of 12 soil poisons 2 years ago. Almost 2,000 blocks of Southern pine wood were placed in the treated plots and check plots. Results indicate that 7 of the treatments were highly effective for controlling the four fungi for the 2-year period. Five treatments had scarcely any effect. Further tests have been begun.

White Pine
Blister Rust

The Station cooperates closely with the College of Forestry of New York State University at Syracuse in research on white pine blister rust. The College has increased the ribes population in an area in which selections of eastern white pine are exposed to rust infection to determine possible disease resistance. Field and laboratory work on the relationship of the pycnial and the aecial stages of the rust are nearing completion.

White Pine
Durability

Plans are being developed for a cooperative study with the College of Forestry of the New York State University at Syracuse on relative durability of white pine trees. The objectives of the project will be to determine the variations in durability among white pines growing in a limited area and to relate durability to site, tree characteristics, and insect and disease infection. It is planned to follow these studies with a search for criteria by which individual living trees that have natural resistance to decay fungi may be selected for future forest-tree-improvement programs.

Diseases Of
Exotic Trees

An annotated list of diseases of foreign forest trees growing in the United States has been prepared for publication as a Department of Agriculture Handbook, the second in the series of handbooks on Forest Tree Diseases of the World.

--MARVIN E. FOWLER
Chief, Division of Forest Disease Research

Forest Economics

DURING 1956, as in previous years, our research in forest economics followed two general programs. The first was the Forest Survey. More initial surveys were made; they now cover about 87 percent of the Northeast. Resurveys were started. The other program is resource economics. Under it studies were continued in forest-products marketing, and more timber-resource analyses were made. New work was begun in forest-production economics.

FOREST SURVEY

Progress

The initial forest survey in the Northeast is gradually nearing completion. In 1956 nearly 3 million acres in Maine were inventoried, bringing the total to 7,300,000 acres in the state. This amounts to 43 percent of the forest-land area of Maine. In New Jersey 1,275,000 acres of forest land were covered by the initial survey and field work in that state was completed. Delaware is the only state where the field inventory has not been started.

As in past years, excellent cooperation from state officials and private industry continued. Photography was provided by the New Jersey Conservation Department, the Maine Forest Service, the Maine Bureau of Taxation, and the Great Northern Paper Company. In addition, state-owned airplanes in Maine considerably speeded up the field work by transporting our crews and equipment to areas that are inaccessible by car.

The timber-products output and timber-cut phase of the Forest Survey was completed in New Jersey. It was also undertaken in Delaware, since the inventory will be started and finished there early in 1957. In the course of this work additional data were obtained on the relationship of

stump diameter to diameter at breast height for the more important tree species. We now have sufficient data to analyze the stump-d.b.h. relationships for pitch pine, spruce, hemlock, Virginia pine, white oak, chestnut oak, white ash, basswood, hickory, and black cherry. The information on these species will be published in 1957. Information on six other species has already been published.

Techniques Research

The Forest Survey does not stop when the initial inventory is complete. Up-to-date statistics on forest area, timber volume, timber cut, and timber growth are continuously needed. To obtain current data, several states in the Station's territory must be resurveyed relatively soon.

To try out a more efficient system for this resurvey, 100 plots in New Hampshire, established in late 1946, 1947, and early 1948, were revisited. The original plot centers were located and measurements were taken of the trees measured previously. When these data are analyzed, we will know how many survey plots will have to be revisited to provide growth, mortality, and timber-cut data that meet our accuracy standards. In addition, numbers of new plots needed to provide adequate current inventory volume can be calculated. The data obtained from remeasuring these 100 plots will also provide part of the basis for new estimates of volume, growth, and timber cut.

Aerial photography has been used to increase the efficiency of the Forest Survey since its inception. However, it has had rather limited use. Aerial photographs have been used to separate forest from nonforest land, and to stratify the forest land into a series of volume classes. Also, photo-pairs covering the field-plot location are used by the field crews to establish these plots more accurately. It has been felt that survey costs could be reduced appreciably through broader use of aerial photographs.

During the past year, in cooperation with the Maine Forest Service, a series of aerial photographs on both panchromatic and infra-red film were obtained, at varying scales (1:1000, 1:5000, and 1:15840). During the fall, a series of control plots were established within the area covered by these flights. Precise ground measurements of diameters, heights, crown widths, and stand densities were

taken. During the winter, photos of these same areas will be examined stereoscopically. If certain tree characteristics obtained through photo-interpretation can be correlated with plot volume, expensive field-plot establishment can be reduced materially.

Full coverage with aerial photography is costly. Larger scale strip-photography offers the possibility of reducing the cost of aerial photographs. Through the cooperation of the Maine Forest Service, part of eastern Maine was flown in strips at approximate 10-mile intervals. The scale of this photography is 1:5000. Ground plots were established and measured this summer. These data will be analyzed early in 1957 to determine the relative efficiency of strip-photography vs. 100-percent coverage.

RESOURCE ECONOMICS

Resource-economics research during the year included the analysis of timber resources in states where the forest survey has been completed, and studies of the economic aspects of various timber-growing and marketing alternatives.

A report on the timber resource in Massachusetts has been published. It gives summaries of classifications of forest area and timber volume, volume of annual growth, and volume of timber cut. A similar report for Rhode Island is being prepared for printing, and reports for Connecticut and Pennsylvania have been written. A report analyzing the timber resources of New York, written in cooperation with the New York State University College of Forestry and the New York Conservation Department, was published late in the year.

During the year the Station continued its active participation in a cooperative study of the forest-product-marketing practices of the region's forest owners. It joined with eight agricultural experiment stations in summarizing these practices and the factors that influence them and in preparing a printed report.

To gain the greatest benefit from our forest resources, foresters must be able to channel timber into the uses for which it is best suited. Studies designed to provide guides for evaluating timber quality for various uses are an important part of the Station's research program. In

cooperation with the New York State University College of Forestry, work continues on a study of white pine log grades. The factors that influence timber quality for shoe-last material is the subject of another active Station study. And, in cooperation with the Forest Products Laboratory, a report is being prepared on stress grades for farm dimension lumber. These studies should help foresters provide the basis for more efficient forest-product-marketing practices.

White pine production, from seedling to product, is the scope of a new economic study of timber-growing alternatives. This study will supplement a similar study already in progress in the Midwest. It is designed to provide the region's forest managers with economic guides for evaluating prospective investments in planting, insect and disease control, pruning, thinning, and other white pine production alternatives. The study may require several years to complete.

--STAFF
Division of Forest Economics Research

Forest Utilization

THE KEYNOTE of the Station's utilization program is and has been an effort to improve the technology of the wood-based industry to the point where a forest owner can remove any tree that should be removed, receive a reasonable stumpage return for it, and have the wood move to an industry that will use it to good economic purpose. Acting as the Northeastern outpost of the U. S. Forest Products Laboratory, the Division of Forest Utilization Research performs its function by a continuous study, in a more or less detail, of all of the segments of the many-faceted wood-based industry. Some of the more important subjects investigated in 1956 were the following:

Short-Log Bolters

Significant new developments included hydraulic feed works, automatic off-bearers, and a novel plant set-up that permits experiments in efficiency as governed by machine relationships.

Debarkers & Residue Chippers At Sawmills

There has been a tremendous and desirable expansion in this field. At the start of the year, there were seven log-debarker installations in the region, chiefly in Maine. By the end of the year 33 were operating or being installed in four states. One operator installed a log debarker solely to gain the benefits of more efficient sawing; others were installed with the idea of preparing heavy residues for pulp use. In addition, six slab debarkers have been installed to process coarse residues from smaller sawmills.

Charcoal

Of approximately 350 charcoal-producing installations in the United States, 100 are located in the Northeast. Although a wet season caused poor recreational and household markets, the movement to produce charcoal continues strong. During the year a rotary kiln and briquetting equipment were installed in Connecticut, a French can unit in New York State, a continuous chip process in Pennsylvania, and an improved handling system for the Connecticut-type kiln in Maryland.

Residues

Volumes of primary plant residues used continued to increase due to growing uses in metallurgy, agriculture, charcoal, and pulp. Better manufacturing practices also aided in increasing amounts used.

Timber Quality

A Regional Forest Service Log Grade Committee was set up to deal with problems of timber-quality evaluation. Membership includes representatives of all interested divisions of the Station. Contributions were made to the new Forest Service publication TIMBER QUALITY NOTES. A preliminary edition of a log-grading manual was prepared. In collaboration with our Division of Forest Economics, investigations were made into the comparative values of hard maple grade logs for last blocks and for lumber. Interest of industrial foresters in timber-quality standards is increasing.

Hardwood For Pulp

This important movement continues to roll. The "bugs" have been worked out of a large chemi-groundwood installation; two pilot plants for testing the Forest Products Laboratory cold-soda process have been built; many mills are expanding their operations (one by 100 percent) to utilize more hardwood, and two new mills that will use hardwood are planned. Consumption of hardwoods by the pulp industry in this region has increased in the last 15 years until now one-third of all pulpwood used is dense hardwood.

Other studies were made of veneer grading, last-block production, possibility of manufacturing white pine veneer, the status of the dimension-stock industry, logging damage on long-log operations, and the utility of a hydraulic wedge for use in felling timber.

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To supplement such investigations, efforts were made to coordinate or encourage research into important problems and to assure the free flow and prompt use by industry of research findings on equipment, processes, products, and systems. Because of staff limitations, this activity was carried out on a wholesale basis, i.e., advantage was taken of local (and national) organizations that are interested in and have facilities to disseminate technical information to large numbers of potential users.

In 1956 the Station Division of Forest Utilization Research worked in this way with the following organizations: Forest Products Research Society, Northeastern Wood Utilization Council, Northeastern Loggers' Association, New England and Keystone Kiln Drying Associations, and National Safety Council, Wood Working Section. Members of the Division are active in these organizations as officers and advisors, in committee work, and in arranging programs.

The workshop or clinic is a device of proved value for both problem analysis and dissemination of information. In 1956 we arranged for or participated in ten of these, with combined attendance of 300. Subjects included wood-seasoning, sawmilling, packaging, log-grading, and forest photography. One of these clinics--the Amherst Kiln Drying Clinic, sponsored by the New England Kiln Drying Association --is now an established annual affair; the 1956 clinic was the fifth.

In addition to working with formally organized groups, the Division personnel from time to time advised various groups interested in industrial development. These include the Williamsport (Pa.) Development Bureau, the Berwick (Pa.) Industrial Plan, the Pennsylvania Development Commission, the Pennsylvania Department of Labor, the Garrett County

(Md.) Forestry Board, and the Pennsylvania Railroad Development Division. Great interest has been shown in the possibilities of wood particle-board production and wood seasoning.

There were a variety of other activities. Partly in connection with the International Cooperation Administration's training program, visitors from Australia, Thailand, Turkey, Yugoslavia, Sweden, Norway, Japan, Mexico, and England were given information on U. S. technology by means of conferences and field trips. A bulletin dealing with the establishment and operation of small sawmill enterprises was prepared for the International Cooperation Administration. A member of the Division acted as advisor to the United Nations Food and Agriculture Organization's Forestry equipment panel.

Specific aid was also given to regional industries by correspondence, telephone, and office consultation. About 250 such inquiries were handled during the year. Division personnel edited a booklet published by the Northeastern Wood Utilization Council (Bulletin No. 44, "A Guide to Wood Preservatives and Wood Preservation"). A number of articles on new developments were prepared for publication by various trade journals.

--C. R. LOCKARD
Chief, Division of Forest Utilization Research

Publications

in 1956 by staff members and cooperators of the Northeastern Forest Experiment Station, Forest Service, U. S. Dept. of Agriculture.

(Adams, W.R., Baker, Gregory, Beal, G.M., Goodspeed, A. W., McGuire, J.R., and Ostrander, M.D.)
1956. MARKETING FOREST PRODUCTS FROM SMALL WOODLAND AREAS IN THE NORTHEAST. I. SELLING PRACTICES OF WOODLAND OWNERS AND EXTENT OF HOME USE OF TIMBER PRODUCTS. Vt. Univ. Agr. Expt. Sta. Bul. 595. 83 pp.

Report on a study by the Northeastern Regional Technical Committee, Cooperative Regional Research Project NEM-6. Covers woodland ownership and composition, home use of woodland products, sales of woodland products, products marketed, and marketing practices.

*Armstrong, George R., and Bjorkbom, John C.
1956. THE TIMBER RESOURCES OF NEW YORK. Northeast. Forest Expt. Sta. 38 pp., illus.

Reports the findings of the first comprehensive survey of the forests of New York State, made in 1949-52 by the U.S. Forest Service. Describes the importance of forests to New York's economy, current wood utilization in New York, the present timber supply, and condition and ownership of the forest land. Recommendations for attacking New York's forest problems are made.

*Banks, Wayne G.
1956. CLOSE WOODS UTILIZATION COMMONLY PRACTICED IN DELAWARE. Northeast. Forest Expt. Sta., Forest Res. Note 60. 1 p.

Study of logging operations showed that loggers cut 78 percent of their pine trees to stumps no more than 6 inches high. They cut hardwoods a bit higher. Good utilization of below-grade material was also observed.

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*Copies or reprints available from the Northeastern Forest Experiment Station, 102 Motors Avenue, Upper Darby, Pa.

*Batzer, Harold O., and Waters, William E.
1956. FOREST TENT CATERPILLAR. U. S. Dept. Agr. Forest Pest Leaflet 9. 4 pp., illus.
Describes the forest tent caterpillar (Malacosoma disstria Hbn.), its hosts, injury it causes, life history, natural control, and chemical control.

Carlson, Charles A., Reinhart, K.G., and Horton, J.S.
1956. PREDICTING MOISTURE IN THE SURFACE FOOT OF SOIL. Soil Sci. Soc. Amer. Proc. 20 (3): 412-415, illus.
Wetting in the surface foot was found to depend primarily on the amount of rainfall and the amount of space available for storing water. Information needed for prediction includes field maximum moisture content, transition dates for seasonal depletion curves, and size of the smallest storm that affects soil mositure.

*Curtis, Robert O.
1956. ESTIMATING COSTS OF IMPROVING ADIRONDACK TIMBER STANDS BY KILLING CULLS WITH FRILLS AND SODIUM ARSENITE. Northeast. Forest Expt. Sta. Forest Res. Note 63. 4 pp.
Regression equations are offered for use in estimating costs in terms of man-hours of labor and amount of silvicide solution required.

Davis, J.M., Waters, W.E., Isler, D.A., Martineau, R., and Marsh, J.W.
1956. EXPERIMENTAL AIRPLANE SPRAYING FOR SPRUCE BUDWORM CONTROL. Jour. Econ. Ent. 49: 338-341, illus.
In tests of aerial spraying made in Canada in 1951, sprays of three different atomizations (fine, medium, and coarse) were applied at three dosages ($\frac{1}{4}$, $\frac{1}{2}$, and 1 pound DDT per acre) at two stages of larval development (third instar and fourth-fifth instars). Results indicate optimum spraying time, dosage, and atomization.

Diller, Jesse D.
1956. "SCREENING" THE AMERICAN CHESTNUT FOR BLIGHT RESISTANCE. Northeast. Forest Tree Improve. Conf. Proc. 3: 2-4.
Describes the continuing search for and testing of American chestnut trees that have survived the blight. Tests are made with American chestnut scions girdle-grafted onto Chinese chestnut rootstock.

*Fenton, Richard H.
1956. POUND POLES: A PROFITABLE MARKET FOR VIRGINIA PINE. Jour. Forestry 54: 38-39, illus.

The fishing industry in the Chesapeake Bay area has need for long slender poles to support fish nets in shallow waters. A study of a pound-pole cutting showed that it was profitable and had no bad effect on the stand: the best poles are obtained from intermediate trees in dense pulpwood-size stands.

*Fenton, Richard H.
1956. PRODUCTION AND USE OF WOOD CHIPS FROM VIRGINIA PINE THINNINGS. Northeast. Forest Expt. Sta., Sta. Paper 80. 14 pp., illus.

Thinnings from a dense and limby stand of Virginia pine in Maryland were converted into chips, which were tested for use as cattle bedding and poultry litter. Data on thinning study, wood and chip yield, chipping production rates and costs, and tests of chipped material in use.

*---------- and Berry, Frederick H.
1956. HEART ROT OF VIRGINIA PINE IN MARYLAND. Northeast. Forest Expt. Sta. Forest Res. Note 56. 4 pp.

Heart rot was studied on 168 Virginia pine trees and the sawing of 382 logs cut from them to determine (1) the relationship between indications of rot and the volume of unmerchantable wood; (2) the entry points of the rot; and (3) the actual merchantable volume loss.

*Ferguson, Roland H., and Howard, Milford C.
1956. THE TIMBER RESOURCE IN MASSACHUSETTS. Northeast. Forest Expt. Sta. 45 pp., illus.

An analytical report on the findings of the forest survey of Massachusetts, describing the economic importance of the timber resource, raw-material demands of the timber-using industries, condition of the present forests, and data on ownership, forest types, growth and cut, timber volume, and timber quality. Forest-type map in color.

Gabriel, William J.
1956. PRELIMINARY REPORT ON CLONAL DIFFERENCES IN THE WOOD AND PHLOEM OF POPULUS DELTOIDES AND P. TRICHOCARPA. Northeast. Forest Tree Improve. Conf. Proc. 3: 33-34.

Tests were made on wood samples of young trees from various localities within the natural range of the two species. Statistically significant differences were found in fiber length and specific gravity. Variations were also apparent in the fiber arrangement in the phloem.

*Godwin, P. A.
1956. AN INSECT TRAP. U. S. Dept. Agr., Agr. Res. Centre ARS-33-22. 4 pp., illus.

Reports development of a trap used successfully for trapping weevils on white pine. A jute tag platform containing tanglefoot is fastened around the tree, covered by a conical canopy of clear acetate. Detailed plans.

---------- and Bean, James L.
1956. PREDICTING EMERGENCE OF THE WHITE-PINE WEEVIL FROM HIBERNATION. Forest Sci. 2: 187-189.

Relates weevil emergence to temperature and suggests a method for determining when the major part of the population has emerged, as a basis for timing spraying operations.

*Hahn, Glenn G., and Eno, Harold G.
1956. FUNGUS ASSOCIATION WITH BIRCH "DIEBACK" AND ITS SIGNIFICANCE. U. S. Dept. Agr. Plant Dis. Rptr. 40 (1): 71-79.

A study was made of crown and root fungi isolated from dieback birch in Maine and New Hampshire. Organisms tested proved to be saprophytic, or at most very weakly pathogenic. The possibility that birch dieback is an infectious fungus disease is not supported by any positive evidence.

Hart, Arthur C.
1956. LOGGING ON THE PENOBSCOT EXPERIMENTAL FOREST. Northeast. Logger 5 (6): 33, 90-91, illus.

Logging on the Penobscot Forest is done in connection with studies of different intensities of forest management, chemical debarking treatments, and the like. Chainsaws are used for felling and bucking, a tractor with rubber-tired sulky for skidding. Much progress has been made in mechanizing the operations on the Forest.

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1956. CHANGES AFTER PARTIAL CUTTING OF A SPRUCE-FIR STAND IN MAINE. Northeast. Forest Expt. Sta., Sta. Paper 86. 8 pp., illus.

A 1945-46 cutting reduced the probable vulnerability of the stand to spruce budworm damage and increased the stand productivity by eliminating large fir and poor-vigor fir and spruce. However, the proportion of non-merchantable species in the stand increased.

*----------
1956. RESULTS OF SMALL WOODLOT CUTTINGS ON PENOBSCOT EXPERIMENTAL FOREST, 1953 and 1954. Northeast. Forest

Expt. Sta. Forest Res. Note 61. 2 pp.

Reports financial returns from experimental cuttings on small forest properties put under management in 1951

Hastings, A. R.

1956. GRANULATED ENDRIN FOR WHITE PINE WEEVIL CONTROL DURING HIBERNATION. Jour. Econ. Ent. 49: 878.

Preliminary tests of granulated Endrin, spread over the surface of the duff, showed considerable promise for controlling the white pine weevil in the hibernation stage. (Most insecticidal control methods are directed against the adult stage.)

*Hutnik, Russell J.

1956. PLACING OUR NORTHERN HARDWOOD WOODLOTS UNDER MANAGEMENT. Northeast. Forest Expt. Sta., Sta. Paper 82. 24 pp., illus.

Describes management of northern hardwood woodlots by means of two case studies, an old-growth woodlot and a second-growth woodlot on the Bartlett Experimental Forest in New Hampshire. Describes each woodlot, takes the reader on a reconnaissance of it, and discusses possible treatments, marking the timber, logging it, and costs and returns.

Lewis, F. B.

1956. ON THE TIBIAL COMB OF CERATOPOGONIDAE (DIPT.) AND ITS POSSIBLE USE IN DETERMINING THE NEARCTIC SPECIES OF CULIERIDES. Canada. Ent. 88 (9): 546-552.

*Little, S., and Somes, H. A.

1956. BUDS ENABLE PITCH AND SHORTLEAF PINES TO RECOVER FROM INJURY. Northeast. Forest Expt. Sta., Sta. Paper 81. 14 pp., illus.

Pines severely damaged by fire, cutting, and animal browsing often recover by putting out new shoots. One source of these is the development of buds in the needle fascicles below the point of injury. But more commonly the recovery is made through shoots from dormant buds.

*---------- and Somes, H. A.

1956. THINNING YOUNG OAK STANDS ON POOR SITES IN SOUTHERN NEW JERSEY DOES NOT PAY. Northeast. Forest Expt. Sta. Forest Res. Note 58. 4 pp.

A thinning study was made on the Lebanon Experimental Forest in New Jersey in 1935, on the notion that growth of residual stems would be stimulated. Study of the results in 1935 showed that the thinning had produced no practical benefits.

*Little, S., and Mohr, J. J.
1956. CHEMICAL CONTROL OF HARDWOODS ON PINE SITES OF MARYLAND'S EASTERN SHORE. Northeast. Forest Expt. Sta. Forest Res. Note 64. 4 pp.

Report on 10 experimental treatments (use of ammate and 2,4,5-T and one girdling treatment) for killing worthless hardwoods. During the last 3 years hardwoods on about 2,000 acres of state and private land have been treated with 2 percent 2,4,5-T in No. 2 fuel oil, applied in frills.

Lockard, C. R.
1955. A GUIDE TO WOOD PRESERVATIVES AND PRESERVATIVE TREATMENTS. INTRODUCTION. Northeast. Wood Util. Council Bul. 44: 3-5.

One reason why more treated wood is not used in building construction is lack of readily available information about what treatment to use and how to specify the treatment. Bulletin lists specifications and sources of information.

McGuire, John R.
1956. FUTURE PUBLIC PLANTING POLICIES AND THE REGIONAL FOREST ECONOMY. Soc. Amer. Foresters New England Sect. Proc. Winter 1956: L 1-9.

General discussion of present public reforestation policy, its costs and benefits; suggests some possible alternatives. In the future as in the past, planting policy is likely to be based more on trial and error rather than on economic evaluation.

McLintock, T. F.
1956. FOREST TREE IMPROVEMENT IN THE SPRUCE-FIR REGION. Northeast. Forest Tree Improve. Conf. Proc 3: 65-69.

There is little need for planting in the spruce-fir region of the Northeast, yet there are two ways in which genetical knowledge can be applied in silviculture here. One is for the forester to recognize desirable genotypes when the tree is relatively small; the other is to anticipate what effect environment will have upon a genotype.

*McQuilkin, W.E., McNamara, E.F., Reigner, I.C., and Lull, H.W.
1956. REPORT NO. 3: FOREST AND WATER RESEARCH PROJECT, DELAWARE-LEHIGH EXPERIMENTAL FOREST. Pa. Dept. Forests and Waters. 44 pp., illus. Harrisburg.

Progress report on cooperative watershed studies and scrub oak conversion studies, with some notes on fire control. Tabular data on watershed study: precipitation,

discharge, groundwater levels, soil moisture content, soil freezing, and climatic factors.

Marquis, Ralph W.

1955. REPORT FOR THE NORTHEASTERN FOREST EXPERIMENT STATION TO THE SECOND LAKE STATES FOREST TREE IMPROVEMENT CONFERENCE. Lake States Forest Tree Improve. Conf. Proc. August 30-31, 1955: 23-28, illus. (Lake States Forest Expt. Sta. Misc. Rpt. 40.)

Outlines forest genetics research of the Northeastern Forest Experiment Station in hybridization and mass-production of hybrids, racial tests, individual tree selection, study of exotics, and field testing.

1956. NORTHEAST REPORTS ON GENETICS STUDIES. Lumberman 83 (13): 57, 112-114.

The Northeastern Forest Experiment Station began its genetics program in 1935 with studies of hybrid poplars. The program has steadily broadened. The present program is outlined and some results are reported. Studies now include a number of species. Hybridization, racial tests, individual tree selection, exotics, and field tests.

1956. TIMBER RESOURCE REVIEW FACTS BEARING ON THE PINE-HARDWOOD SITUATION. Soc. Amer. Foresters Allegheny Sect. News 9 (1): 6.

Describes the timber resource in the Allegheny Section of Pennsylvania and the productivity of various classes of forest land. Data based on nationwide Timber Resource Review made by U. S. Forest Service.

1956. FOREST RESEARCH IN THE NORTHEAST. South. Lumberman 193 (2417): 193-194.

Outlines history of forest research in the Northeast in the last 75 years, from the small-scale plantation silviculture of early foresters to the broad-scale integrated research carried on today by the Federal forest experiment stations. In the Northeast, attention is turning more and more to the potential value of hardwood stands and hardwood sites.

*Mook, Paul V., and Eno, Harold G.

1956. RELATION OF HEART ROTS TO MORTALITY OF RED SPRUCE IN THE GREEN MOUNTAIN NATIONAL FOREST. Northeast. Forest Expt. Sta. Forest Res. Note 59. 2 pp.

A study of butt rots in dead and dying old-growth red spruce at high elevations in the Green Mountain National Forest found no evidence that presence of rot affected the trees except perhaps that it made them more liable to windfall.

*Nearn, William T.

1956. USE OF BEECH IN ROUGH CONSTRUCTION ON THE FARM. Northeast. Tech. Com. Util. Beech and Northeast. Forest Expt. Sta., Beech Util. Ser. 14. 6 pp.

Beech is becoming more prevalent in the farm woodlots of the Northeast; and a farmer might profit by using beech from his woodlot for construction work on his farm. Some special attention to careful seasoning is necessary.

*Northeastern Forest Experiment Station.

1956. 1955 ANNUAL REPORT. Northeast. Forest Expt. Sta. 118 pp., illus.

Special report on the insect problem in the Northeast: economic importance, progress in control work, specific current problems, and the Station's research program in insect surveys, biology and ecology, biological control, and chemical control. Appendix contains descriptions of more than 30 major insect pests. Also: brief reports on Station work in forest management, watershed management, forest economics, forest diseases, and forest utilization. Annotated list of publications.

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1956. FOREST STATISTICS FOR THE NORTH-CENTRAL SECTION OF PENNSYLVANIA. Northeast. Forest Expt. Sta., Forest Statis. Ser.: Pa. 4. 16 pp., illus.

Forest-survey findings for the section of Pennsylvania that includes Potter, Tioga, Cameron, Clinton, Lycoming, and Sullivan Counties: forest area, ownership, forest types, and timber volume. Tabular data and brief description of forest resource.

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1956. FOREST STATISTICS FOR THE NORTHEASTERN SECTION OF PENNSYLVANIA. Northeast. Forest Expt. Sta., Forest Statis. Ser.: Pa. 5. 16 pp.

Forest-survey findings for the section of Pennsylvania that includes Bradford, Susquehanna, Wayne, Wyoming, Lackawanna, Pike, and Monroe Counties.

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1956. FOREST STATISTICS FOR THE SOUTHWESTERN SECTION OF

PENNSYLVANIA. Northeast. Forest Expt. Sta., Forest Statis. Ser.: Pa. 6. 16 pp.

Forest-survey findings for the section of Pennsylvania that includes Armstrong, Indiana, Cambria, Blair, Beaver, Allegheny, Westmoreland, Somerset, Washington, Fayette, and Greene Counties.

*Northeastern Forest Experiment Station.

1956. FOREST STATISTICS FOR THE SOUTH-CENTRAL SECTION OF PENNSYLVANIA. Northeast. Forest Expt. Sta., Forest Statis. Ser.: Pa. 7. 16 pp.

Forest-survey findings for Centre, Union, Snyder, Mifflin, Juniata, Perry, Bedford, Fulton, and Franklin Counties.

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1956. FOREST STATISTICS FOR THE ALLEGHENY SECTION OF PENNSYLVANIA. Northeast. Forest Expt. Sta., Forest Statis. Ser.: Pa. No. 8. 16 pp., illus.

Forest-survey findings for Warren, McKean, Forest, Elk, Clarion, Jefferson, and Clearfield Counties.

1956. NORTHEASTERN FOREST PEST REPORTER. NO. 1. Northeast. Forest Expt. Sta. 7 pp. (New Haven.)

Reports current status (July 1956) of important insect and disease pests in the Northeast.

1956. NORTHEASTERN FOREST PEST REPORTER. NO. 2. Northeast. Forest Expt. Sta. 7 pp. (New Haven.)

Periodic summary of forest insect and disease conditions in the Northeast, August 1956.

1956. NORTHEASTERN FOREST PEST REPORTER. NO. 3. Northeast. Forest Expt. Sta. 5 pp. (New Haven.)

Periodic summary of forest insect and disease conditions in the Northeast, September 1956.

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1956. THE TIONESTA NATURAL AND SCENIC AREAS IN THE ALLEGHENY NATIONAL FOREST. Northeast. Forest Expt. Sta. 22 pp., illus.

Booklet describing the Tionesta Forests, their history and present condition. Notes on special points of interest.

Ostrander, M. D.

1956. BUCKING TREE-LENGTH HARDWOODS FOR HIGHEST VALUE PRODUCTS. Northeast. Logger 5 (2): 27-31, 73, illus.

Describes bucking methods based on U. S. Forest Products Laboratory log grades. Examples of grade yields from different bucking methods.

Potts, S. F.

1956. CHEMICAL CONTROL OF BRUSH ALONG POWER LINES. Conn. Arborist 10 (2): 24-27.

There are three general methods for controlling brush with chemicals: basal stem treatment, stump treatment, and foliage treatment. Each has advantages for certain situations. Techniques with and uses for dilute and concentrated foliage sprays are described.

Rushmore, Francis M.

1956. THE ADIRONDACK RESEARCH CENTER. Northeast. Logger 4 (12): 20-21, 50, illus.

Describes research work carried on at Northeastern Forest Experiment Station's research center at Paul Smiths, New York. Some details on use of chemicals for killing and debarking trees.

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1956. THE FRILL: A NEW TECHNIQUE IN CHEMICAL DEBARKING. Jour. Forestry 54: 329-331, illus.

A broad girdling of the tree is not necessary for a chemical debarking treatment. A simple frill of ax cuts is equally effective.

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1956. A SMALL QUANTITY OF SODIUM ARSENITE WILL KILL LARGE CULL HARDWOODS. Northeast. Forest Expt. Sta., Sta. Paper 83. 6 pp., illus.

Tests with various dosages of sodium arsenite and ammate indicate that large cull beech, yellow birch, and sugar maple in the Adirondacks can be killed, within 3 years, by placing 2 cc. of sodium arsenite solution in holes bored at 8-inch intervals around the tree.

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1956. BEECH ROOT SPROUTS CAN BE DAMAGED BY SODIUM ARSENITE TREATMENT OF PARENT TREE. Northeast. Forest Expt. Sta., Forest Res. Note 57. 4 pp.

Experiments in the Adirondacks showed that sodium arsenite applied to beech trees in bored holes can move down and out through the roots to kill root sprouts.

*Sartz, Richard S., and Trimble, George R., Jr.
1956. SNOW STORAGE AND MELT IN A NORTHERN HARDWOODS FOREST. Jour. Forestry 54: 499-502, illus.

A preliminary study of snow storage and melting behavior in the White Mountains of New Hampshire indicates that snow accumulation in hardwood forests could be increased and the snow pack prolonged by cutting narrow openings in an east-west direction.

Schreiner, Ernst J.
1956. REPORT ON A RECONNAISSANCE OF PINUS SYLVESTRIS IN SPAIN. Northeast. Forest Tree Improve. Conf. Proc. 3: 38-42, illus.

Poor timber form has brought Scotch pine into disfavor with many American foresters. However, the excellence of Scotch pine grown in Spain suggests a possibility of planting Spanish Scotch pine in America. Briefly discusses distribution in Spain; stem form, growth, and color; taxonomy; and management.

Simmons, Fred C.
(1956.) PRIMARY WOODUSING INDUSTRIES OF BRITISH HONDURAS. Internatl. Coop. Adm. 25 pp., illus.

Report on an advisory mission to British Honduras, with recommendations for improving operation of sawmills and for improving utilization of the forest resource.

1956. LOGGING AND MILLING IN BRITISH HONDURAS. Yale Forest School News 44 (1): 3-5, illus.

Report on an ICA assignment in British Honduras as sawmill consultant. Describes forest conditions, primitive logging methods, and hazardous hauling. Sawmilling practices need much improvement; inaccurate sawing, great waste of lumber volume, and extravagent use of manpower are major problems.

1956. LOGGING AND MILLING IN BRITISH HONDURAS. Northeast. Logger 4 (7): 10-12, 42, illus. (See above.)

1956. HYDRAULIC WEDGE FOR TREE FELLING. Northeast. Logger 5 (2): 23, illus.

Reports on tests of a hydraulic wedge designed for West Coast logging. The wedge has plenty of power, but for Northeastern conditions it is too heavy, too expensive, and

does not have enough lift to topple many of our large-topped hardwoods in the direction opposite the lean.

Simmons, Fred C.

1956. THE EATON LUMBER CO....MULTI-PRODUCT HARDWOOD SAWMILL. Northeast. Logger 5 (3): 20-21, 54, illus.

This lumber company in Vermont, which saws 12 to 15,000 board feet of hardwood lumber daily, uses a chain-flail debarker of its own invention to debark logs before sawing. The mill sells its sawdust for stock bedding, and converts slabs, edgings, and trim into pulpwood chips. The debarking, sawing, chipping, and chip yields are described.

1956. A LOOK AHEAD IN NORTHEASTERN SAWMILLING. Forest Prod. Jour. 6: 292-296.

The portable sawmill is passing out in the Northeast: the trend is toward permanent mills of medium size. The author predicts increased use of automatic machinery, more effort to turn waste into byproducts, and more use of specialized mills such as the sash gangsaw and the short-log bolter saw.

1956. TRENDS IN THE NORTHEASTERN LUMBER INDUSTRY. Northeast. Logger 4(9) : 12-13, 30-32, illus. (See above.)

--- and Bethel, James S.

1956. INTRODUCTION in HANDBOOK FOR SMALL SAWMILL OPERATORS. Amer. Soc. Mech. Engin. ASME 109. 62 pp., illus.

Small sawmills can produce accurately sized lumber if they are well constructed, properly maintained, and correctly operated. This handbook summarizes the causes for miscut lumber in small mills and indicates the action sawmill operators can take to eliminate these faults.

--- and Bethel, James S.

1956. HANDBOOK FOR SMALL SAWMILL OPERATORS. INTRODUCTION. Forest Prod. Jour. 6: 105-108, illus. (See above.)

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1956. SAWMILL RESIDUES: THEIR PRODUCTION AND USE IN THE NORTHEAST. South. Lumberman 193 (2417): 204-207.

A report on the production and use of residues such

as sawdust, slabs, edgings, and shavings. The author concludes that, all in all, Northeastern sawmill men are doing very well in reducing the amounts of residues they produce to a minimum, and in finding profitable markets for the residues they do produce.

Simmons, Fred C.

1956. THE QUESTION CORNER.
Northeast. Logger 4 (7): 33.
Northeast. Logger 5 (2): 63.
Northeast. Logger 5 (5): 55.

Replies to loggers' and sawmill operators' questions. The questions asked most often related to methods of debarking logs and chipping coarse residues at sawmills, use of wheel tractors in logging, and charcoal manufacture.

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1956. 956 YEARS OF LUMBERING IN THE NORTHEAST.
South. Lumberman 193 (2417): 227-229.

Lumbering began in the Northeast about 1,000 A.D., when Leif Ericson sailed to "Markland" to bring back a load of timber. Outlines the history of lumbering and lumber production from colonial days to the present, with its hopes that Northeastern lumbering may soon get back to the level of 5 to 6 billion board feet of production that it once maintained for nearly a hundred years.

1956. FULL TREE UTILIZATION IN WEST VIRGINIA.
Northeast. Logger 4 (8): 10-12, 34-35, illus.

A case study of operations by the Meadow River Lumber Company of Rainelle, W. Va. The company does its own logging (by railroad), brings trees full length to the mill for bucking. Lumber, flooring, shoe-heels, and dimension stock are produced from sawlogs; cull sections, tops, and heavy residues are made into chips for metallurgical uses.

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1956. SCALING PRACTICES AT NORTHEASTERN SAWMILLS.
Northeast. Forest Expt. Sta., Sta. Paper 87. 9 pp.

A survey of scaling practices used at more than 800 sawmills revealed great variation in application of the log rules used (International, Doyle, Maine, Vermont, Scribner). There is a great need for instruction in accurate methods of scaling.

*

1956. THE MILLING OF BEECH.

Northeast. Tech. Com. Util. Beech and Northeast. Forest Expt. Sta., Beech Util. Ser. 16. 27 pp., illus.

A key factor in the utilization of beech is the kind of sawmilling techniques used. Discusses types of sawmills, power-speed-feed relationships, dogging, sizing accuracy, and techniques of sawing beech logs. Problems of getting good logs, handling and storing beech lumber, and marketing beech lumber are also discussed.

*Spaulding, Perley.

1956. DISEASES OF NORTH AMERICAN FOREST TREES PLANTED ABROAD. U.S. Dept. Agr., Agr. Handbk. 100. 144 pp.

An annotated list describing the diseases (viruses, bacteria, fungi, and mistletoes) found on North American trees planted abroad. Indexes of hosts, species planted, and location of plantings where diseases have occurred.

*Trimble, G. R., Jr., and Lull, Howard W.

1956. THE ROLE OF FOREST HUMUS IN WATERSHED MANAGEMENT IN NEW ENGLAND. Northeast.Forest Expt. Sta., Sta. Paper 85. 34 pp., illus.

Part of a problem analysis for watershed-management research in New Hampshire. Describes development, classification, and functions of humus and outlines research projects needed to fill gaps in our knowledge of humus and its influence.

*---------- and Weitzman, Sidney.

1956. SITE INDEX STUDIES OF UPLAND OAKS IN THE NORTHERN APPALACHIANS. Forest Sci. 2: 162-173, illus.

The productivity of most forest land in the northern Appalachians can be estimated from information on (1) aspect, (2) position on slope, (3) grade of slope, and (4) total soil depth. Relationship of other factors (ground cover, length of clear bole, humus type and depth, pH) to site are also discussed.

*---------- and Weitzman, Sidney.

1956. CHAFF SEEDING--ONE ANSWER TO SOIL WASHING ON LOGGING ROADS. W. Va. Conserv. 19 (12): 12-13, illus.

Chaff from farm harvesting operations, spread over skid roads and log decks, proved effective for stabilizing disturbed areas that otherwise might have eroded. Based on studies at the Fernow Experimental Forest in West Virginia.

*Waterman, Alma M.

1956. VERTICILLIUM WILT OF YELLOW-POPLAR.

U.S. Dept. Agr. Plant Dis. Rptr. 40 (4): 349-350.

Reports Verticillium albo-atrum isolated from a wilting yellow-poplar tree at Milford, Conn., although this species had not been previously reported as a host of this disease. Unfavorable growing conditions may have contributed to the weakening of the tree.

*Waters, W. E.

1956. FOREST INSECT CONDITIONS IN THE NORTHEAST--1955. Northeast. Forest Expt. Sta., Sta. Paper 79. 19 pp.

A survey of forest insect outbreaks now active in the region, their distribution and severity; and survey and control plans for 1956. Special notice is taken of the spruce budworm, pine sawflies, pine looper, Matsucoccus scale, balsam woolly aphid, forest tent caterpillar, gypsy moth, beech scale, and saddled prominent.

*Webster, Henry H.

1956. AN ECONOMIC ANALYSIS OF MINE-TIMBER MARKETING IN WEST VIRGINIA. Northeast. Forest Expt. Sta., Sta. Paper 84. 24 pp., illus.

In West Virginia, the mine-timber market no doubt has a great effect on the policy decisions of many forest owners and managers. The author describes the present marketing systems, demand and supply, and how they interact.

Weitzman, Sidney.

1956. RESEARCH ON THE FERNOW EXPERIMENTAL FOREST. Northeast. Logger 4 (7): 14-15, 31, illus.

General description of research program on the Fernow Experimental Forest in West Virginia, including studies of commercial logging, farm forests, and watershed management.

---------- and Lindahl, Robert R.

1956. ELIMINATE WORTHLESS TREES ! Va. Forests 11 (4): 4-7, illus.

Use of a silvicide (ammate) and different methods of girdling were tested for removing culls from Appalachian hardwood stands. Ammate has an advantage: it gives a higher percentage of kill and kills more quickly. Costs, time of treatment, and other factors are discussed.

*Westveld, Marinus.

1956. NATURAL FOREST VEGETATION ZONES OF NEW ENGLAND. Jour. Forestry 54: 332-338, illus.

Report of a Society of American Foresters committee, outlining methods and principles followed in preparing a nat-

ural vegetation map for New England. Includes descriptions of forest vegetation zones established and an allocation of SAF forest cover types to established zones. Includes map (black and white); 6-color map also available.

*Wilson, R. W., Jr.
1956. INJURY TO WHITE PINE CROWNS IN NORTHERN NEW ENGLAND IN 1955. Northeast. Forest Expt. Sta. Forest Res. Note 62. 5 pp.

Discusses possible causes of unusual development of white pine terminal shoots due to some sort of damage. Most likely causes traced to weather conditions.

*Wright, Jonathan W.
1956. CONE CHARACTERISTICS AND NATURAL CROSSING IN A POPULATION OF F_1 PINE HYBRIDS. Ztschr. f. Forstgenetik 5 (2): 45-48, illus.

Report on a study of natural crossing in a plantation of P. densiflora x sylvestris and P. thunbergii x densiflora hybrids and their parent species in central Pennsylvania. Cone characteristics were used as a means of identifying hybrid progeny.

1956. CULTIVATED SPRUCES IN THE PHILADELPHIA AREA. Univ. Pa. Morris Arboretum Bul. 7: 52-57, illus.

Describes the American, European, Japanese, Chinese and other Asiatic spruces grown in the Philadelphia area and their relative merits for different uses. Notes on where to obtain spruce seed and seedlings.

--- and Baldwin, Henry I.
1956. REPORT ON AN 18-YEAR-OLD SCOTCH PINE PROVENANCE TEST IN NEW HAMPSHIRE. Northeast. Forest Tree Improve. Conf. Proc. 3: 18-21.

Summary of 18-year measurements of scotch pine planting made in New Hampshire in 1938 as part of International Union of Forest Research Organizations project.

*Wyman, Edgar P.
1956. BEECH FOR CROSSTIES. Northeast. Tech. Com. Util. Beech and Northeast. Forest Expt. Sta., Beech Util. Ser.: 15. 13 pp., illus.

In strength properties and resistance to wear, beech is comparable to other species used for crossties; and when handled properly in logging, seasoning, and treating, ties made from selected beech have given very satisfactory service.